WIDA FOCUS ON

STEM Discourse: Strengthening Reasoning, Strengthening Language

In This Issue

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The students in Julie's seventh-grade math class are beginning a unit on polynomials. Their first task is to sort cards, each of which shows a single polynomial. The classroom is buzzing, and students in the small groups—all of them, English learners (EL) and non-ELs—are arguing about categorization methods. Although several students ask Julie if what they're doing is correct, or how many categories they should have, she responds to their queries with questions that probe their reasoning and keep them working toward clarification as a group. *"I see you have these three things grouped together. Can you explain why? Do you all agree on that? No?—Oh, you think something different? Can you explain your thinking? Interesting...see what you can all figure out together."* This is a very different scenario than it would have been one year ago, when students would have been working—silently and alone, and with limited success—on worksheets involving polynomial equations. Julie and her students have spent a year working in a different paradigm: one that focuses on the Standards for Mathematical Practice, on collaborative reasoning, and on learning through academic discourse.

Supported by a 3-year grant from the National Science Foundation, developers Rita MacDonald, Emily Miller, and Sarah Lord worked with 4th and 7th grade math and science teachers to try out and revise the resources shown here.

Let's move now to a fourth-grade classroom, where co-teachers Kristen and Holly are introducing their students to a unit on the respiratory system. In this classroom with a high percentage of ELs, groups of three or four students are curiously examining the contraptions they've each been handed, made of a plastic cup, a small balloon, and some straws and pieces of rubber sheeting. They discover that when they move one piece of the contraption, other pieces move.

They will eventually make a connection between these moving pieces and the interacting components of the respiratory system, and will be eager to learn the names of those components that they can clearly see working together. After 10 minutes, Kristen and Holly ask students to get ready to share their group's idea about what parts of the respiratory system are represented by the various parts of the model, and also to justify their reasoning. The groups do not appoint speakers, since they know that any one of them may be asked to speak for the group. They know that if they need assistance with their wording of ideas, their classmates—ELs and non-ELs—will help them, and that they will also hang in there with them if their explanations are a bit difficult to understand. This is a different scenario than it would have been last year, before Kristen and Holly and their students had begun using the Teacher Discourse Moves and Student Discourse Moves to develop a rich discourse practice in their classroom.

These teachers and students all work in a school district that's made a commitment to implementing disciplinary practices in STEM classes—the eight Standards for Mathematical Practice and the eight Science and Engineering Practices—and to using discourse-centered instruction to simultaneously strengthen student's reasoning and language. Teachers have been meeting monthly to experiment with a set of resources developed with support from the National Science Foundation. Although they're using the resources differently, they are all seeing benefits for ELs and all students in their classrooms, and are impressed by how hard students are working to clarify and explain their ideas.

What's different about education today?

New content standards such as the Common Core State Standards and the Next Generation Science Standards, as well as the college- and career-ready state standards, focus our attention on students' critical thinking and collaborative problem-solving. These are skills that spill beyond school into family life, successful work, and civic engagement. Additionally, experts in science education and mathematics education have outlined the Standards for Mathematical Practice (http://www.learnnc.org/lp/editions/math-CCSS-resources/7508) and the Science and Engineering Practices (http://ngss.nsta.org/PracticesFull.aspx) that highlight the activities that students engage in as they integrate the concepts of these disciplines. These new standards about disciplinary practices in mathematics and science remind us that learning science or math is much more than memorizing formulas or procedures or taxonomies. Learning math and science means learning how to think in particular ways, and it means doing things such as arguing from evidence and creating models to help explain our emergent understanding. When we help our students engage together in these practices by facilitating their discussions of complex ideas, we provide multiple opportunities for all our students to become more effective English users. We also provide rich and interesting experiences that may support students' future interest and engagement in STEM careers.

The strong emphasis on students' critical thinking and collaborative problem-solving transforms the work of teaching and learning in powerful ways. With the input of teachers on this project, we developed this description of the new roles we're all being invited to step into.

The Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

The Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

NEW ROLES FOR ALL

TEACHERS

- Create opportunities for students to reason together about things that matter.
- Focus more on students' thinking than their answers.
- Support perseverance in understanding one another's thinking.
- Model complex/precise language and discuss the pros & cons of using it.

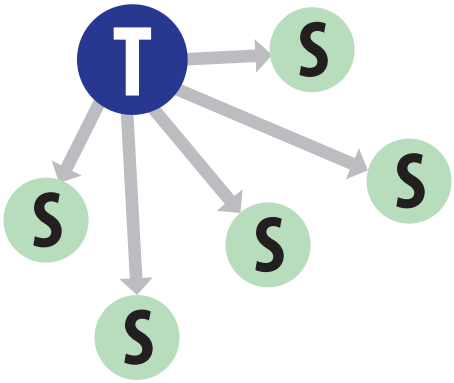
STUDENTS

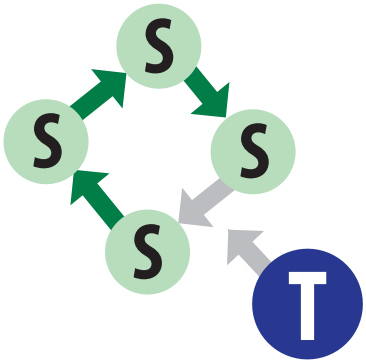
- Make your response to ideas known; support, challenge, or question ideas.
- Check for accurate understanding of others' statements; keep at it until you understand one another.
- Follow ideas; listen carefully, track the logic. Does it make sense? Is something missing?

A New Playing Field

Focusing on student reasoning and collaborative discourse sometimes requires a change in classroom norms for participation and interaction for both teachers and students. As one teacher in the NSF project remarked, "New or old teacher, it doesn't matter. We're all on a new playing field today!"

A new playing field calls for new moves on everyone's part. Compare the two models of classroom interaction patterns shown on the right.





Which one gives students more responsibility for thinking deeply and collaboratively? Which one provides more opportunities for students to use and strengthen their languages?

We've known for quite a while that the model on the top, often named IRE for teacher **Inquires**, student **Responds**, teacher **Evaluates** (Schegloff, 2007) offers few opportunities for students to say more than one or two words. In this model, only a small number of students get to speak, and most ELs don't volunteer responses in such a high-pressure, quick-response situation. We also know that the IRE pattern offers the teacher very little useful information. Knowing that a student offers a right answer or the wrong answer doesn't reveal much about the student's reasoning. The reasoning-centered, discourse-focused model on the bottom, however, when skillfully managed, offers multiple opportunities that the IRE model does not.

- Opportunities for every student to express and clarify new ideas
- Opportunities for students to strengthen their communication skills and to learn language on an as-needed basis from and with one another
- Opportunities for teachers to listen in on students' reasoning, and to probe and guide their reasoning by posing questions or offering new information
- Opportunities for teachers to listen in on students' language use and to offer models through revoicing to increase a students' effectiveness with English

Moving to a discourse-centered learning environment has provided many benefits to both teachers and students.

> *"For the first time in 25 years, I'm certain that my students understand this. They don't need to memorize formulas or math jingles. They really understand the math." – a seventh grade algebra teacher*

> *"Our ELs are speaking up and offering ideas in ways they never did before. They feel smart now, and they feel proud, and they're willing to take risks with their language to share their thinking."– a fourth grade teacher*

> *"When I do my walk-arounds, I see 100% engagement in high-level math discussion. That's never happened before, and it's exciting." – principal in a participating school*

The WIDA Focus Bulletin on formative language assessment gives a more extensive review of the benefit of obtaining frequent samples of student language. https://www.wida.us/get.aspx?id=215

New Moves

Together with experts in math and science education and with participating teachers, we developed a set of resources to support this move toward a reasoning-centered, discourse-rich style of instruction. The three components that yield the powerful results described above are based on a theory of language learning described as **language as action.**

> "Only an emphasis on language as action … engages students in the meaningful learning of new disciplinary practices while simultaneously strengthening their language uses in those practices." (Heritage, Walqui, & Linquanti, 2015, p. 32).

This approach to supporting students' language development works well in content classrooms, since it's focused on helping students do meaningful things with language during their content learning. In this approach, we focus on helping ELs learn language while and through doing math or science alongside their classmates—not beforehand or as separate from math or science. Language serves as a tool for meaning-making, and learning is intimately connected to shared activity and to students' need to construct meaning together.

The approach builds on the fact that, when it comes to learning science or math, ELs are meaning-makers along with their peers. Everyone in the class is learning new ideas, and everyone is learning new language. The spiral shown here captures the essence of the language as action approach with ELs in science.

We recognize that ELs come to their science classrooms with multiple ideas about how the world works (green strand). They also have experience in making meaning in one or more languages, and varying degrees of effectiveness with English (blue strand). Given these strengths, ELs are well able to engage in scientific reasoning and, when properly supported, able to engage in discussion of their reasoning. If we educators are successful in tapping into ELs' assets and capacities and can position ourselves as facilitators of student reasoning (purple strand), we can engage ELs with their classmates in the collaborative sense-making practices of science (the words

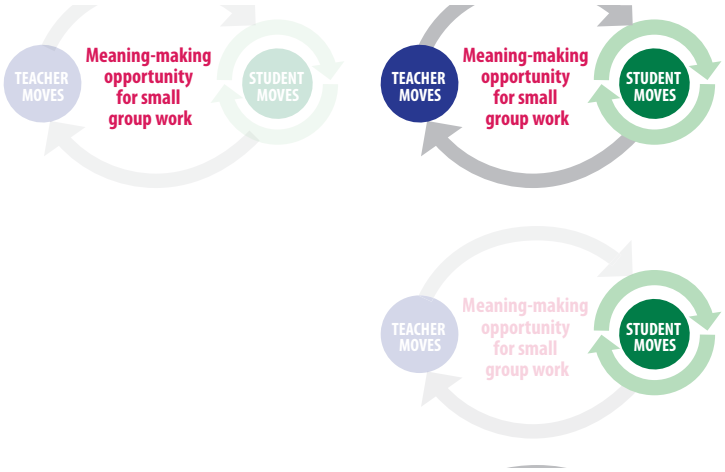
spiraling around the center). With this approach, both ELs' knowledge of science and their linguistic effectiveness in science will be strengthened.

With a few changes to the wording in the center, we can see how this would apply to the mathematics classroom as well.

In both cases, the need for students to make sense of ideas together serves as the engine that drives language development.

> *"Our ELs are getting more comfortable with speaking up even if they're uncertain of their wording, and our non-ELs have become much more helpful to our ELs as they figure out how to word their ideas. And, by questioning one another, asking for clarification, and being patient with one another as they figure out different ways of saying something—by persevering with one another—students are helping one another learn language."* – *fourth grade teacher*

The three components of this approach are described next.



Although they're described separately, and can be learned and practiced in a variety of combinations, they work together and we need some of each component put into play before we see the benefits of the approach.

But for now, let's learn about these one at a time. Later in this brief, you'll learn some tips from teachers who've integrated this new way of teaching and learning into their classrooms.

Create Opportunities for Students to Reason Together

If you look back at the earlier description of new teacher roles, you'll see that the first step is to provide rich opportunities for students to reason together about things that matter. That last phrase—"about things that matter"—is an important one to think about. Many of us have been taught that putting students into small groups is a good idea, and small group work is indeed central to this way of teaching and learning. Simply putting students into small groups, though, is not sufficient to achieve the gains we desire for our students. Too often, group time is spent on task management rather than shared analysis of ideas. Similarly, ELs are often given passive roles as listeners or as scribes for those who take more active roles in the processing of ideas. The resources we share here are designed for ELs to join their classmates as initiators of ideas and to share in the analysis of complex challenges and ideas. As shown in the spirals above, when students collaborate to construct new meaning together, their collaboration strengthens both their content knowledge and their language.

> The WIDA Focus Bulletin on group work [https://www.wida.us/get.aspx?id=604] describes additional ways to enhance the opportunity that small group work provides ELs.

> "Meaning is not stored language, but stored experience. Language can express what is known, but it does not, in and of itself and absent experience, create or contain meaning. To learn what things mean, then, and what language means—to create meaning—requires immersion in experience." (MacDonald & Molle, 2015, p. 42).

How do we construct rich opportunities for students to reason together? What are some hallmarks of effective meaning-making activities?

- Most importantly, the activity, or challenge, or question that educators provide their students should not lead to one right answer or strategy. Rather, students should be asked to come up with several ways of doing or explaining whatever is central to the activity.
- The activity should be multi-layered; after coming up with many strategies or ideas, students should be asked to analyze why each method works or to explain why they think some

ideas are better than others. Spiraling through the ideas at these deeper levels of analysis provide important opportunities to reason and to strengthen the language students need to explain their complex thinking.

Both NCTM and NGSS have resources that can be helpful as we look for activities to stimulate students' reasoning, and additional resources for finding possible activities are listed near the end of this bulletin. A seventh-grade algebra teacher in our project reported that it's gotten easier to find relevant activities. She simply searches the internet for "meaning-making activities for seventh grade algebra!"

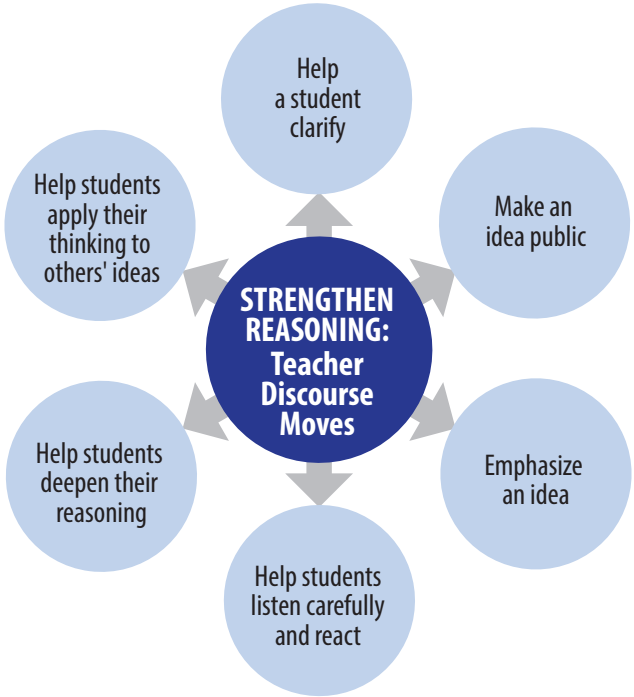
Suggestions from others include looking at the activities at the end of a chapter, often labeled as extension activities and too often reserved for students who need an additional challenge. Using those at the beginning of a unit, rather than at the end, can stimulate a lot of thinking and can jump-start students' sense-making. The fourth-grade science activity described at the beginning of the chapter is an example. A more typical way of introducing that unit on the respiratory system would have been to give students a list of key words and definitions, accompanied by diagrams and descriptions of organ functions—and only then, much later in the unit, asking students to create their own representations of the dynamic system. By starting with the more interesting and challenging activity, these teachers awakened students' curiosity and interest, got them invested in learning what they were soon to be immersed in, and learned a lot about what their students did and did not already know, as well as the language they use to collaborate around ideas.

We know from experience that creating opportunities does not guarantee that students will feel comfortable stepping forward into those opportunities. All students need time to get used to the idea that teachers are genuinely interested in their ideas, and not just in getting to the right answer quickly. Some students may come from cultures in which students are expected to learn silently and to memorize what experts tell them. Other students may be full of interesting ideas, but have little experience in how to insert them into the flow of an academic conversation, or little confidence that their classmates will have sufficient patience with their sometimes halting or imperfect language use. Both the Teacher Discourse Moves and Student Discourse Moves described below are critical to supporting students in taking important steps to engage with one another in the discourse of learning.

Teacher Discourse Moves to Facilitate and Deepen Students' Reasoning

Giving small groups of students an intriguing question to work through together or an interesting phenomenon to explain sets the stage for students to share ideas and for teachers to support students' developing skill in careful, critical thinking and in effective communication. Teacher facilitation of students' reasoning involves listening in, and deciding if and when to highlight some ideas by revoicing them, when to point out a contradiction in their collective thinking that the students themselves did not catch, and when to model an alternate way of expressing an idea. The work always involves helping students listen carefully to one another, do their best to express their own thinking, and to think carefully about the idea that's developing among them.

> "Essentially all of the science and engineering practices require student discourse to be a central element of classroom activity, and, properly managed by the teacher, such discourse includes all students and pushes every student to refine and extend language abilities." (Quinn, 2015, p. 14).



This graphic shows the six Teacher Discourse Moves: several ways to probe and strengthen students' reasoning, to keep their ideas moving forward, and to keep students talking to one another.

Teachers in our project found this simple graphic to be the most helpful resource, since it reminded them in quick and simple ways of the strategies they could use to stay out of the old 'teacher as expert' mode and keep the responsibility for the idea in the hands of the students. The complete version of these Teacher Discourse Moves (provided at the end of this brief) gives examples of ways to phrase these moves. Most teachers found the examples effective initially to help them learn the Teacher Discourse Moves, but were able to dispense with them later on. Many simply enlarged and laminated the small graphic of the six Teacher Discourse Moves and kept it nearby as a reminder.

The Teacher Discourse Moves and their purposes are fairly transparent, but some elements deserve a bit of highlighting. Listed under *Help a student clarify his or her thinking* is the hint to allow 20-30 seconds of wait time to elapse before giving a second prompt, and to allow the same amount of time *after* a student has made a remark. Thinking is hard and takes time, and putting complex ideas into words—which we see as academic discourse, even if the language used is halting or imperfect—is not easy. Because we're asking students to engage in academic discourse by "thinking out loud," we need to remember that ideas rarely come out fully developed or clearly articulated the first time, even for the most accomplished and experienced speakers. Waiting patiently for a student to say more often leads her to continue to explore her idea aloud, or to state it more clearly, and this gives others additional opportunities to follow along and think it through with her.

Another important strategy that shows up under *Make ideas public and Help students apply their thinking to others' ideas* is the reminder, when revoicing a student's idea, to always ask the student if you've expressed the idea correctly. After all, it is the student's idea, and we want to make sure our revoicing (perhaps to clarify or to provide a model of simpler or more precise language) doesn't change the idea. We need to build this same habit among our students, as well, so that they respect the integrity of one another's ideas, even as they learn how to express them more clearly. We've observed remarkable examples of ELs persisting in clarifying their ideas aloud in response to this humble question from a teacher: "Did I say that correctly? Try again, please. I'll try to do a better job of understanding."

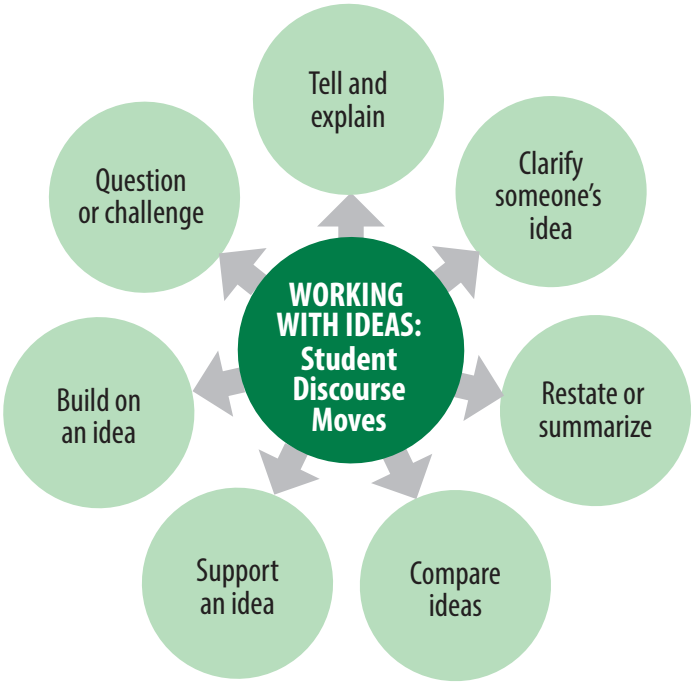
Student Discourse Moves for Collaborative and Critical Thinking

> "For all students, the emphasis should be on making meaning, on hearing and understanding the contribution of others and on communicating their own ideas in a common effort to build understanding …." (Lee, Quinn, & Valdés, 2013, p. 3).

When we present students with intriguing challenges to think through, some will jump right in and others will hold back—some, because they've had years of being trained to spit out correct answers quickly and to keep quiet if they cannot; some, because they have not had much experience in explaining their thinking; some, because they believe that students should be silent and listen; and others, because they're uncertain how to word things so others will understand.

But to activate the collaborative thinking and discussion—the engine driving language development—we need to help students learn new ways of interacting. Students need practice in collaborating to examine issues and build new understandings together.

Just as the Teacher Discourse Moves can be depicted in a simple graphic, so can the seven Student Discourse Moves. The Student Discourse Moves highlight seven things students can do when an idea is on the table.



Teachers have found that using this graphic showing all the moves in one place serves as a good meta-cognitive support. The concept that students are always responsible, every minute, for tracking the development of an idea and for being ready with a response that furthers their own understanding is a new one for many students,

and they need time to get used to the idea. Teachers can support students' use of these moves by being overt about the naming of both Teacher Discourse Moves and Student Discourse Moves as they take place. We've heard one teacher do this very playfully: "I like the way you moved that move there!"

Just as with the Teacher Discourse Moves, the full version of the Student Discourse Moves graphic (provided at the end of this brief) has some examples of language students can use to enact these moves. After an initial learning period, students with a great deal of experience in meaning-making in English seemed not to need these examples. ELs did rely on them for a longer period, and being able to refer to them seemed to help them feel more confident in speaking up since they did not have to create every phrase anew. It's important, however, to make sure students see these only as examples. One good way to do that is to remind students that there are many ways to say things, and to leave some blanks on the page when we teach these to students, so they can create some additional ways of saying these things. It can be helpful to keep a running list somewhere in the classroom of additional examples students come up with, especially if one of those would lead to a good, quick mini-lesson in English.

Teachers with a high proportion of ELs in the classroom found it best to focus on one Student Discourse Move at a time. They posted the graphic of all the moves, and referred to it as they came up in conversation, but chose one move at a time as a lesson focus. Some fourth-grade teachers created color-cued bookmarks for their students, each having one Student Discourse Move with multiple examples of phrasings and some blank spots for students to create their own. These were helpful to the ELs, in particular, but we observed a wonderful interaction in one classroom when an EL could not find his bookmark and another student reassured him, "There are lots of ways to say that. You could say…or… ." This was one of several examples we observed of students learning language from and with one another.

Some moves took longer for students to learn than others, but after a few months, teachers noted that all students were learning newly introduced moves pretty quickly, perhaps because they had more experience with the concept and practice.

Tips for starting and building an effective practice

Our research allowed us to tap into teachers' experience as they experimented with this new way of teaching. Here are some of their insights and suggestions:

- Don't try to do it all at once. Start small. Find some good meaning-making activities, and then practice one or two of the Teacher Discourse Moves to build your confidence.
- Let your students struggle a bit. Productive struggle is actually good for them. It can be hard to watch, and you don't want them to go beyond the frustration point, but it helps them in the long run to learn how to figure things out.
- Give students time to think. "I had my students working on something I thought was pretty simple, but it turned out they needed 20 minutes to figure it out together. It just about killed me to give that much time to something 'so simple,' but in the end, it was the right thing. It wasn't really simple, and now they really understand it." – seventh grade teacher
- "If you've got a curriculum pacing guide that you're supposed to follow, try to get some wiggle room built in. We can't really know, without plunging in, how long it will take for students to work through something challenging—but we do know that the old ways of teaching them definitions and expecting them to remember them doesn't really work, so hold out for enough time for genuine meaning-making opportunities." – fourth grade teacher
- It's important that you understand the ideas deeply yourself. Opening the door to wide-ranging student ideas, giving those ideas respectful consideration, and then weaving all those threads into a new understanding is challenging. Be sure you understand the content well, so you can see multiple ways to deepen students' understanding.
- "Letting go of control is hard--I'm a control freak! Letting go of my idea of the right way or the right answer was hard, but I stuck with it, because I saw how it was helping students."– seventh grade teacher
- "Ask yourself, occasionally, 'What was the most interesting student idea I heard today?' It can be so easy to get caught up in the ideas in the textbook or the curriculum guide that we forget that it's their ideas that are the foundation of whatever gets built. So, when I ask myself this question, it reminds me to pay more attention to their ideas and less to my own." – fourth grade teacher

Success on the New Playing Field

The remarks we've quoted from teachers and administrators in districts that have begun this shift toward discourse-centered instruction and shown the value of working to enact this approach. By creating opportunities where learning is intimately connected to shared activity and to students' need to construct meaning together, and by including ELs as meaning-makers alongside their English-fluent peers, educators are able to work simultaneously on strengthening student reasoning and student language.

Some Sources for Meaning-Making Activities

Co-developers on this grant project—teachers and teacher educators Emily Miller, science expert, and Sarah Lord, expert in the mathematical practices—put together this list of resources for meaning-making activities.

SCIENCE RESOURCES

The National Science Teacher Association has some excellent materials. Go to the NSTA site https://www.nsta.org/ and then go to the drop-down menu Science Standards and choose Classroom Resources. This is the best site to find some curated lessons aligned to a cross-cutting concept, practice, or disciplinary core idea, or all three by searching under the Performance Expectations at your grade level. Also from NSTA, here's a great video of a new teacher http://ngss.nsta.org/ngss-videos.aspx.

Here's a site to help you build lessons based on local phenomena: http://wonderopolis.org/.

These sites have some good science lessons:

- https://concord.org/publications/newsletter/2013-spring/meet-ngss
- http://www.calacademy.org/educators/lesson-plans
- http://nstahosted.org/pdfs/ngss/resources/201401_NGSS-MillerLaufferMessina.pdf
- http://wlresources.dpi.wi.gov has many lessons, curated by Wisconsin science teachers.
- http://ambitiousscienceteaching.org Check out the videos and the discourse primer.

Here are a few places to find good performance tasks for science:

- http://education.vermont.gov/assessment/necap/resources/released-test-items
- http://performanceassessmentresourcebank.org/
- http://ngss-assessment.portal.concord.org/

MATH RESOURCES

Here are some great classroom-focused books:

- Smith, M. & Stein, M. (2011). 5 *Practices for Orchestrating Productive Math Discussions.* Reston, VA: NCTM.
- Leinwand, S., Brahier, D. & Huinker, D. (2014). *Principles to Action: Ensuring Mathematics Success for All.* Reston, VA: NCTM.

Sources for classroom video and lesson studies include the following

- http://www.illustrativemathematics.org Instructional and assessment activities, lesson plans, resources
- http://www.insidemathematics.org Common Core resources, classroom videos, assessment activities, educator tools, problem of the month activities

Check out the Doing and Talking Math and Science website for additional materials, including videos of classrooms, teachers, and administrators and for resources to strengthen your practice.

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Wisconsin Center for
Education Research
University of Wisconsin-Madison
1025 West Johnson St., MD #23
Madison, WI 53706

Client Services Center
toll free: 866.276.7735
help@wida.us | www.wida.us

STAFF

Contributors:
Rita MacDonald

Editor:
Rebecca Holmes

Design:
Janet Trembley
Wisconsin Center for
Education Research

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References

Gee, J. P. (2005). Language in the science classroom: Academic social languages as the heart of school-based literacy. In R. K. Yerrick & W-M. Roth (Eds.) *Establishing scientific classroom discourse communities: Multiple voices of teaching and learning research* (pp. 19-37). Mahwah, NJ: Lawrence Erlbaum.

Heritage, M., Walqui, A., & Linquanti, R. (2015). *English language learners and the new standards: Developing language, content knowledge, and analytical practices in the classroom.* Cambridge, MA: Harvard University Press.

Lee, O., Quinn, H., & Valdés, G. (2013). Science and language for English language learners in relation to Next Generation Science Standards and with implications for Common Core State Standards for English language arts and mathematics. *Educational Researcher, 42,* (4): 223–244.

MacDonald, R. & Molle, D. (2015). Creating meaning through key practices in English language arts: Integrating practice, content, and language. In L. C. de Oliveira, M. Klassen, & M. Maune. (Eds.) *The Common Core Standards in English language arts for English language learners: Grades 6-12* (pp. 39-52). Alexandria, VA: TESOL International.

Quinn, H. (2015). Science and engineering practices for equity: Creating opportunities for diverse students to learn science and develop foundational capacities. In O. Lee, E. Miller, & R. Januszyk. (Eds.) *NGSS for All Students* (pp. 7-20). Arlington, VA: National Science Teachers Association Press.

Schegloff, E. (2007). *Sequence organization in interaction: A primer in conversation analysis* (Vol. 1). Cambridge, UK: Cambridge University Press.

Additional Reading

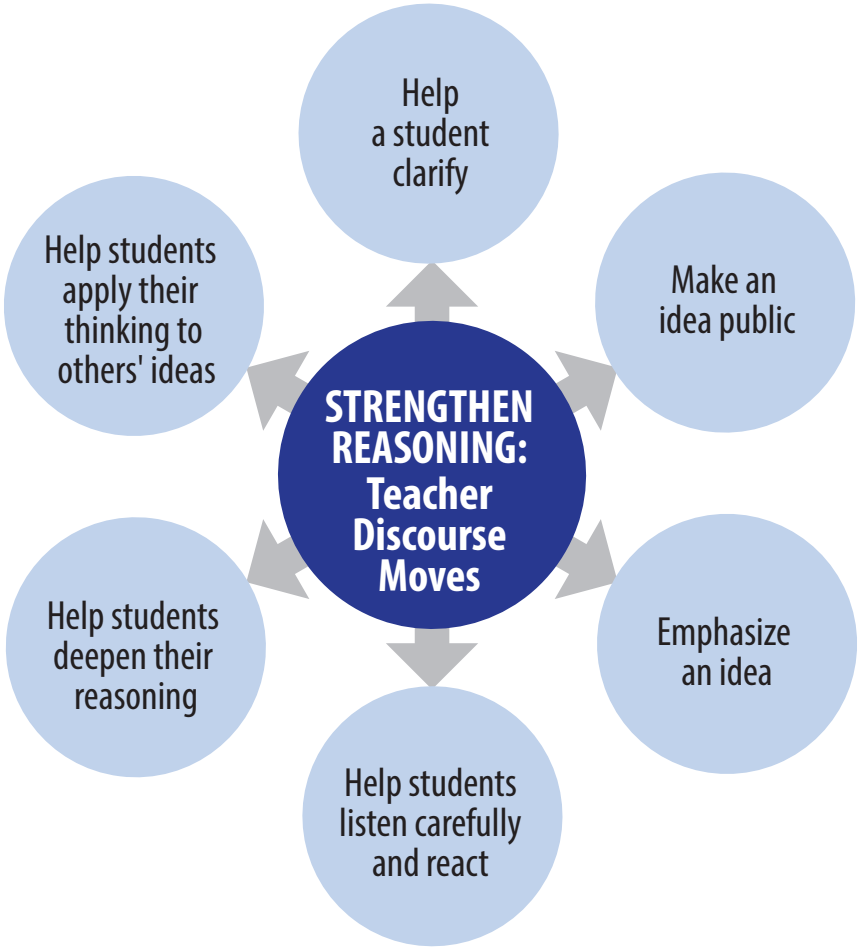
Chapin, S., O'Connor, C., & Anderson, N. (2003). *Classroom discussions: Using math talk to help students learn.* Sausalito, CA: Math Solutions Publications.

Michaels, S., & O'Connor C. (2012) *Talk Science Primer.* Cambridge, MA:TERC. Retrieved from http://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf

Miller, E., & MacDonald, R. (2015). *Rethinking language goals in science: Can three-dimensional learning allow us to shift our thinking around science learning and language goals?* Colorín Colorado TE.L.L.-EGRAM, Feb. 2015. Retrieved from www.colorincolorado.org/article/63672/

Zwiers, J., O'Hara, S., & Pritchard, R. (2014). *Common Core Standards in diverse classrooms: Essential practices for developing academic language and disciplinary literacy.* Portland, Maine: Stenhouse Publishers.

TEACHER DISCOURSE MOVES



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DOING AND TALKING MATH AND SCIENCE
Strengthening Reasoning, Strengthening Language

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/repair 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 revoicing, 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

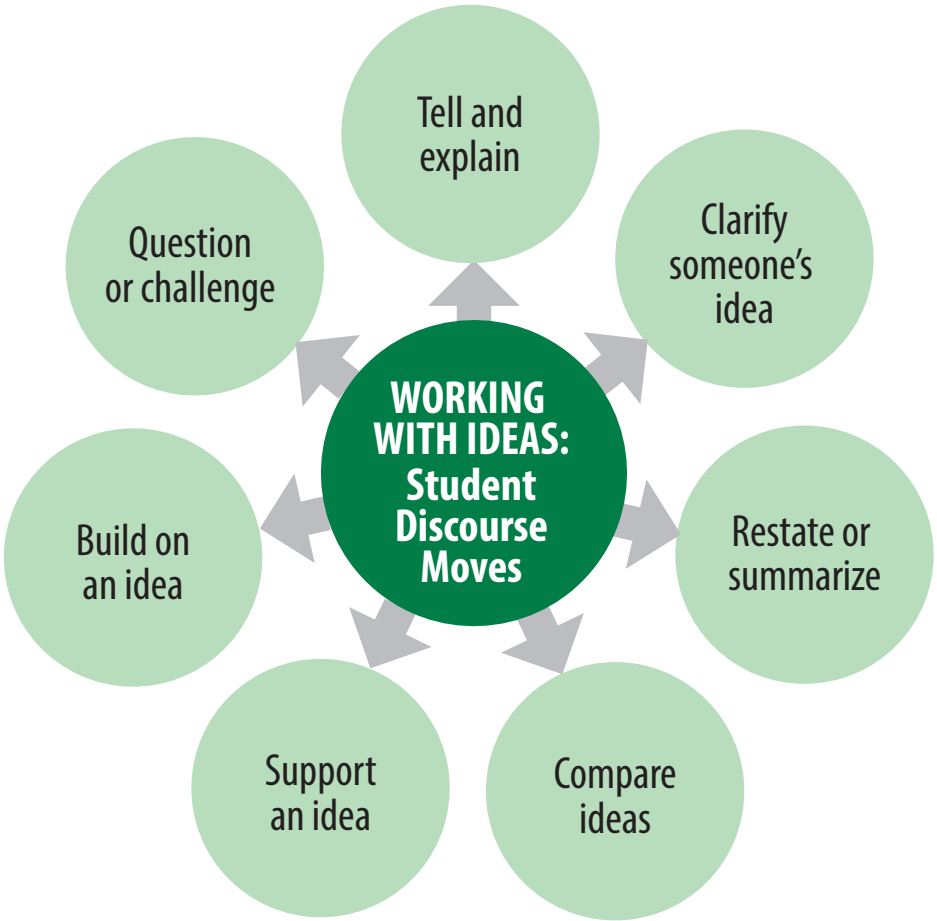
"Who will re-tell that idea for us? Please check back with X to see if you told it correctly."

"Who is ready to tell us the connection 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 or explain a new idea

"I think…"

"I know it will work because…"

"The best strategy would be…."

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."

"Ours 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 …?"

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DOING AND TALKING MATH AND SCIENCE
Strengthening Reasoning, Strengthening Language