



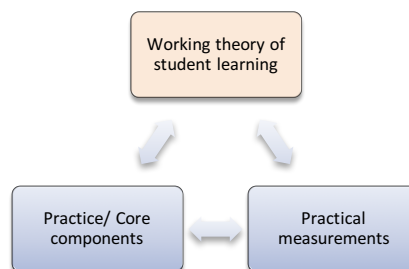
Network Science Teaching Practice #1: Engaging in equitable student-student talk for how/why reasoning

Jennifer Richards, Jessica Thompson, Kerry Soo Von Esch, Christine Chew, Karin Lohwasser, Soo-Yean Shim
Bethany Sjoberg, & Allyson Kemp
University of Washington & Highline School District

As a network of middle and high school science department teams, we are aiming to improve students' written and spoken scientific explanations, models and arguments. One of the discourse practices school teams have named and worked on improving is *equitable talk for how and why reasoning*. Teams of teachers have found this to be particularly helpful practice to focus on at the beginning of a school year as a way to increase student participation in classroom conversations.




Working theory of student learning

Following is an overview of the practice and how it supports students reasoning. It is important to talk about your theory of how students learn with your team of teachers, so that you can develop a common understanding of these ideas, the core components of the practice, and practical measurements that indicate improvement.



Structured talk provides a structure for pairs and small groups to have verbal exchanges in classrooms. Often, we give students time to talk in “turn-and-talk” routines but this is not the same as ensuring that all students have a chance to air out their ideas or practice becoming fluent with scientific terms and concepts. In structured talk students are given roles and equal time for talking. Structuring talk in science classrooms means that students need specific opportunities to reason with how and why a natural phenomenon is occurring—this helps elevate the rigor of the student talk. For example, in Biology students might use structured talk to describe why a lab investigation turned out the way that it did. The rubric below provides an example of the *what-how-why* explanation framework that a group of teachers we worked with developed for a cellular respiration investigation in which students were asked in a structured talk to “Explain **why** you would see an increase in respiration after exercise.” In the investigation students breathed into a Bromothymol Blue (BTB) solution as a direct indicator of carbon dioxide output and an indirect measure of glucose being converted to energy. This rubric helped teachers anticipate what they might hear from students.

	What	How	Why
Depth of Explanation	<ul style="list-style-type: none"> Student describes <i>what</i> happened. Student describes, summarizes, or restates a pattern or trend in data without making a connection to any unobservable/ theoretical components. 	<ul style="list-style-type: none"> Student describes <i>how</i> or partial why something happened. Student addresses unobservable/ theoretical components tangentially. 	<ul style="list-style-type: none"> Student explains <i>why</i> something happened. Student can trace a full causal story for why a phenomenon occurred. Student uses powerful science ideas that have unobservable/theoretical components (like kinetic molecular theory) to explain observable events.

EXAMPLE explanation for cellular respiration investigation	<p>The Bromothymol Blue changed color after exercise because the body exhaled more carbon dioxide as compared to when the body is stationary.</p> 	<p>When exercising the body requires more oxygen. As oxygen intake increases so does the carbon dioxide output.</p> 	<p>When exercising the body requires more oxygen which is taken from the lungs to muscle cells (via the circulatory system and diffusion). The cells use the oxygen to breakdown glucose into energy and carbon dioxide. Muscles use the energy to do work and the carbon dioxide diffuses into the blood and then the lungs and is exhaled. Cellular respiration happens at a faster rate when a person is exercising.</p> <p>Respiration</p> $\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{Energy}$ 
--	---	---	--

Teachers also wanted to have students connect ideas about cellular respiration to equilibrium; they also used structured talk to ask students: “How and why does your body return to a resting rate after being at an elevated rate in terms of gas exchange and breathing rate? How might this be different for a person in good shape versus a person out of shape?”

Why is structuring talk in science classrooms important?

Talk – foundational to science as a discipline: Scientific knowledge does not come unproblematically from the natural world, but rather is built and refined over time as scientists communicate with each other. As noted in the framework underpinning the Next Generation Science Standards, “science is fundamentally a social enterprise, and scientific knowledge advances through collaboration and in the context of a social system with well-developed norms” (NRC, 2012, p. 27). Scientists regularly communicate their findings and ideas with each other and engage in questioning and critique to ensure that the explanations put forth best account for the evidence known at the time.

Talk – to support student learning in science: In line with the understanding that talk is foundational to science, numerous policy and research documents in science education have agreed that the *learning* of science needs to be grounded in its discourse and practices (e.g., Duschl, 2008; Ford & Forman, 2006; NRC, 2012). Students learn key scientific concepts and practices in the context of collaborating to develop robust explanations of scientific phenomena and being pressed to support claims with evidence (Driver, Newton, & Osborne, 2000) and engage in mechanistic reasoning (Russ, Scherr, Hammer, & Mikeska, 2008). These types of talk are not naturally occurring in classrooms—they need to be designed for. Furthermore, studies on collaboration and talk more generally have demonstrated that peers may provide each other with mutual help when they are “equal knowledge partners” working on a shared task together (Donato, 1994; Gibbons, 2002; Mercer, 1995), and that it is key to keep the topic of conversation challenging while making the routine for interacting with each other explicit (Clay & Cazden, 1992; van Lier, 2001). Recent findings from Kuhn (2015) indicate that interacting with opposing ideas or perspectives supports deeper individual learning, in part because it “holds one’s own position to the light” (p. 50), requiring metacognitive reflection that may not otherwise occur.

Talk – to make *all* students’ thinking visible: Supporting students in equitable science talk ensures that all students’ ideas are heard and valued, by both the teacher and their peers. From the teacher’s standpoint, attending to students’ ideas is central to formative assessment (Black & Wiliam, 1998; Levin, Hammer, & Coffey, 2009), enabling the teacher to make instructional decisions and adaptations that build on student thinking moving forward. Students also need to be able to access each other’s thinking, as considering and interacting with varied ideas in the science classroom enhances everyone’s learning (Rosebery, Ogonowski, DiSchino, & Warren, 2010).

Talk – to mitigate pervasive power dynamics: Focusing on equity in talk can renegotiate power dynamics at play in classrooms, where students with perceived social and intellectual capital often dominate. Recurring routines for talk can disrupt these dynamics by creating a new shared set of expectations and norms within the classroom community (Michaels, O’Connor, Hall, & Resnick, 2010). Accompanying these routines must be profound respect

for all students' contributions; "for participation... to be an expectation for all students (not just those who are good at it to begin with), we must presume intelligence" (Michaels et al., p. 39).

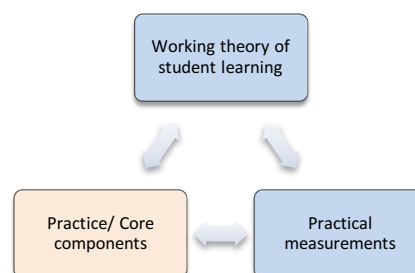
Talk – for EL support: Finally, authentic and supportive talk opportunities provide all students – especially EL students – with relevant contexts to grow in their use of academic language. Taking a socially-oriented view of second language acquisition, the talk opportunities themselves *are* opportunities for language use, and they provide critical access to examples of language functions that are used in analytical tasks like making revisions to a model (Lee, Quinn, & Valdes, 2013).

References

- Black, P., & Wiliam, D. (1998). Inside the black box: Raising standards through classroom assessment. *Phi Delta Kappan*, 80(2), 139–148.
- Clay, M., & Cazden, C. (1992). A Vygotskian interpretation of reading recovery. In L.C. Moll (Ed.), *Vygotsky and education: Instructional implications and applications of socio-historical psychology* (pp. 206–222). New York: Cambridge University Press.
- Donato, R., 1994. Collective scaffolding in second language learning. In J. P. Lantolf and G. Appel, eds. *Vygotskian approaches to second language research*. Norwood, NJ: Albex, 33–56.
- Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, 84(3), 287–312.
- Duschl, R. (2008). Chapter 8: Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, 32, 268–291.
- Ford, M. J., & Forman, E. A. (2006). Redefining disciplinary learning in classroom contexts. *Review of Research in Education*, 30(Special Issue on Rethinking Learning: What Counts as Learning and What Learning Counts), 1–32.
- Gibbons, P. (2002). *Scaffolding language, scaffolding learning: Teaching ESL children in the mainstream classroom*. Portsmouth US: Heinemann.
- Kuhn, D. (2015). Thinking together and alone. *Educational Researcher*, 44(1), 46–53.
- Lee, O., Quinn, H., & Valdes, 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), 223–233.
- Levin, D. M., Hammer, D., & Coffey, J. E. (2009). Novice teachers' attention to student thinking. *Journal of Teacher Education*, 60(2), 142–154.
- Mercer, N. (1995). *The guided construction of knowledge: Talk amongst teachers and learners*. Clevedon: Multilingual Matters.
- Michaels, S., O'Connor, M. C., Hall, M. W., & Resnick, L. B. (2010). *Accountable Talk Sourcebook: For Classroom Conversation that Works*. Pittsburgh, PA: University of Pittsburgh.
- NRC (National Research Council). (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.
- Rosebery, A. S., Ogonowski, M., DiSchino, M., & Warren, B. (2010). "The coat traps all your body heat": Heterogeneity as fundamental to learning. *Journal of the Learning Sciences*, 19, 322–357.
- Russ, R. S., Scherr, R. E., Hammer, D., & Mikeska, J. (2008). Recognizing mechanistic reasoning in student scientific inquiry: A framework for discourse analysis developed from philosophy of science. *Science Education*, 92(3), 499–525.
- van Lier, L. (2001). Constraints and resources in classroom talk. In C. Candlin & N. Mercer (Eds.), *English language teaching in its social contexts* (pp. 90–107). London: Routledge.

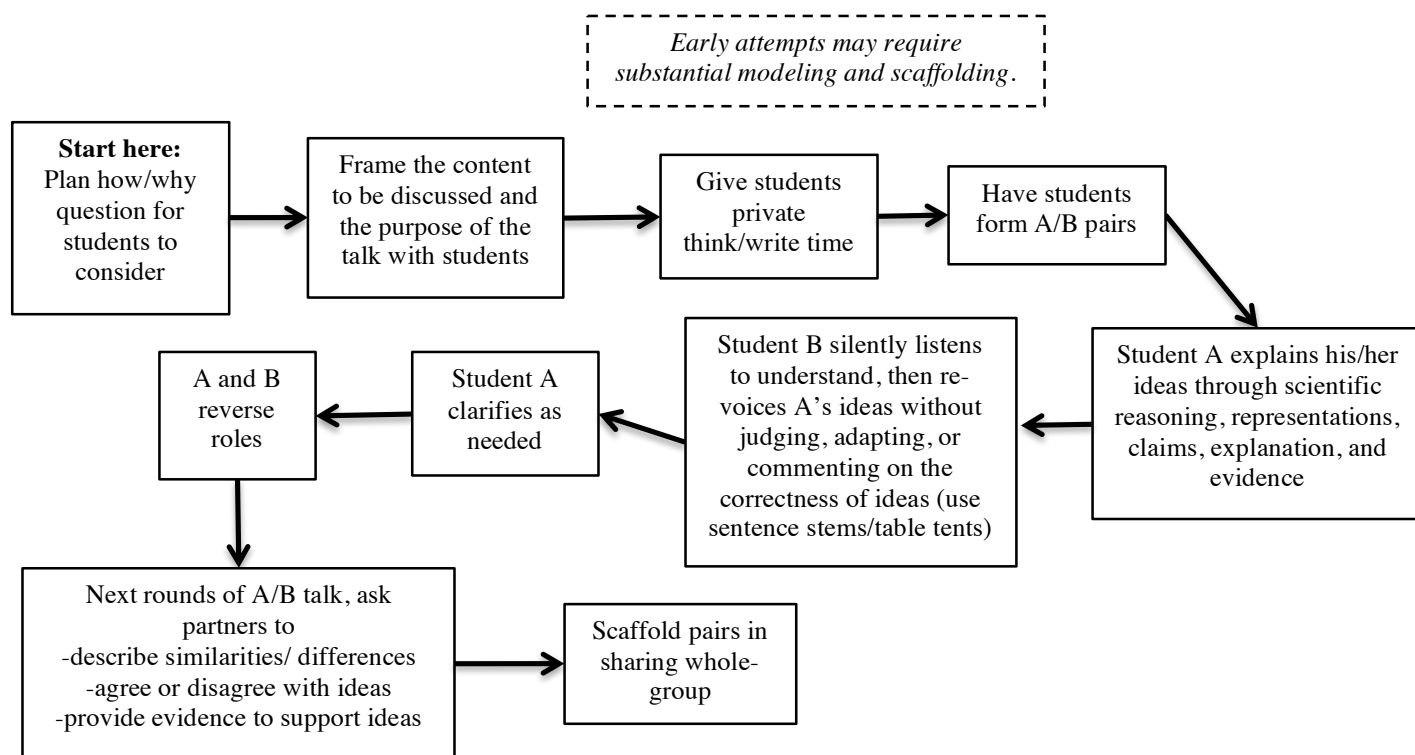
Core Components of the Practice

As a network of middle and high school science department teams, we are aiming to improve students' written and spoken scientific explanations, models and arguments. One of the discourse practices school teams have named and worked on improving is *equitable talk for how and why reasoning*. Following is an overview of the practice and the core components of the practice. It is important to talk with your team and watch video of this practice so that you can best collectively try the practice and co-inquire into questions about under what conditions does the practice work best and for whom?



Structured talk is used to address issue of equity and rigor in classroom talk. You may have noticed that some students participate more than other students in substantive science talk – and EL students in particular tend to participate **less** often than other students or that students are less likely to participate in more challenging forms of scientific discourse (e.g., respectfully disagreeing with an idea, asking each other probing questions, etc.). We hypothesize that structured talk will 1) support more equitable participation in substantive science talk and 2) scaffold participation in more challenging forms of talk – both of which will improve access and sense-making by more students, leading to improved scientific explanations.

Here is a flow chart teachers and researchers have developed to specify the practice of structured talk for how and why reasoning.



Structured talk for how and why reasoning is more than just asking students to turn-and-talk. Below are four **non-negotiables** that help define the principles underlying the practice:

- Talk turns are structured and specific roles are explicit for students
- Structured talk in science asks students to extend beyond “what level” explanations

- Each student is required to share his or her own thinking
- Talk is open-ended and encourages students to share multiple responses

Next Rounds of Talk teams of teachers in the network have considered/tried:

- Identifying similarities and differences: After providing explanations students are given additional time in pairs to discuss how their ideas are similar to and different from each other's.
- Providing evidence for explanations (Chinook): After providing explanations students ask each other questions, to press each other's thinking deeper. They ask each other to provide evidence that supports an idea, or to use evidence from one lab/activity/scenario to apply to another scenario, etc.
- Building on or challenging ideas (Chinook, Evergreen, Highline): After providing explanations students are given additional time in pairs to explain why they agree or disagree with each other's ideas. They may add on to or challenge an idea with evidence, or provide an alternative explanation.
- Structuring talk across partners/groups (Evergreen, Renton): After doing turns of structured talk in pairs, the same A/B structure is used to have conversations across pairs. Renton teachers added a written component to structured talk so that one pair of students could see what another discussed:







Date: _____ Question:	
A – What I thought (silent)	B – Listening- What my partner said
C – What my group agreed on (group discussion- talk about your group response to the question and back up your reasoning for why)	

Sample protocol used with students from Chinook (reprint included at the end of this document →

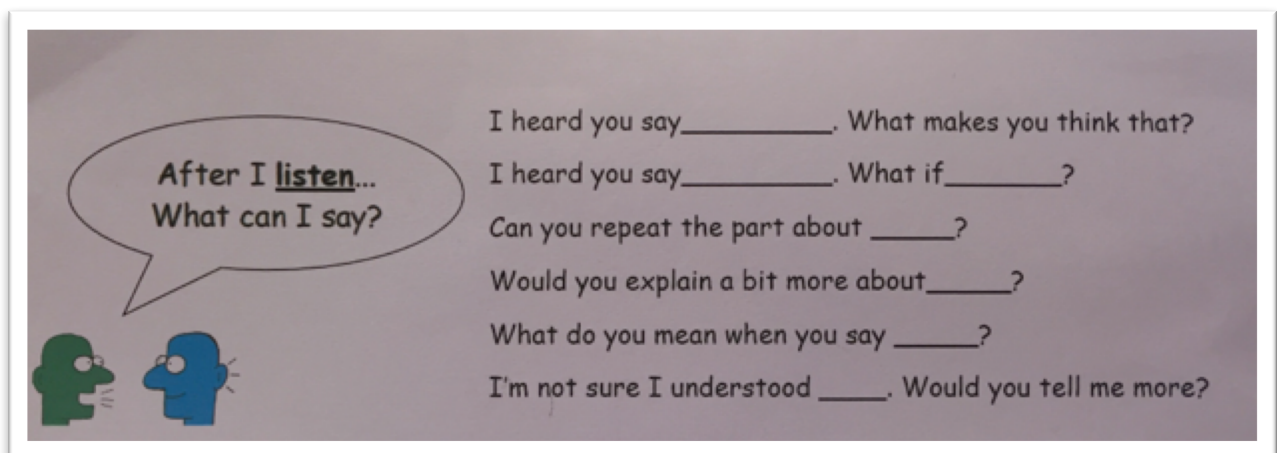
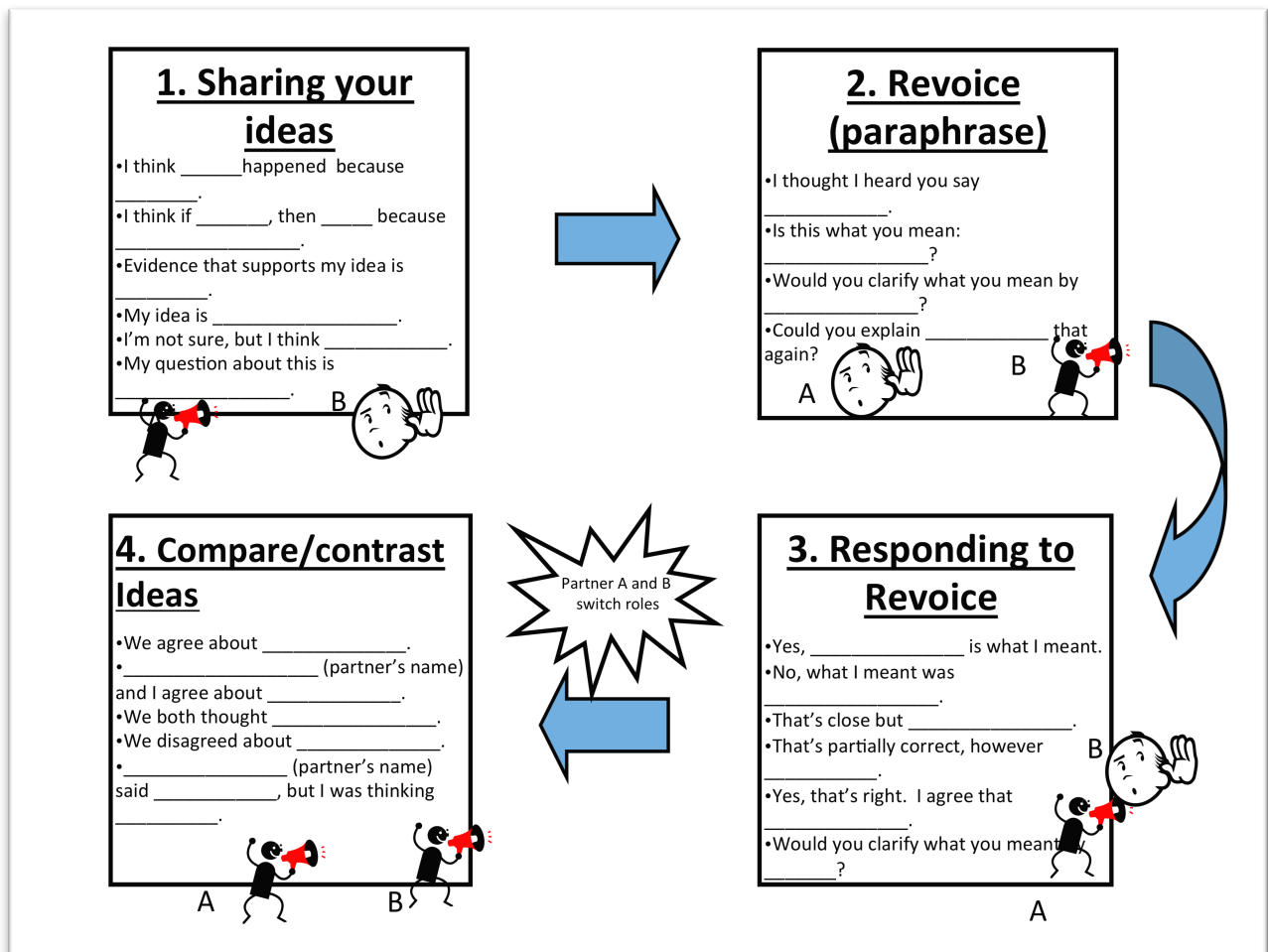
Each of these extensions is a small test of a small change teachers have done with the practice. They come from questions teachers wrestled with when implementing the practice. Here is a list of questions we have seen teachers wrestle with:

- How can we introduce this protocol to students for the first time? Are sentence stems helpful?
- How can we best support students in pressing each other for deeper explanations? Using evidence? Questioning one another? Taking risks and taking each other seriously? Being flexible in their thinking?
- Do EL students need an extra press to express their thinking and not paraphrase others? What should we expect/how can we support different language proficiency levels in structured talk?
- When do we encourage students to use everyday language and when academic language?
- During what part of a unit or particular lesson does this structure work best? How often should it be incorporated? Do students “graduate” from the structure?
- What is the connection between talk and writing?

A/B Partners

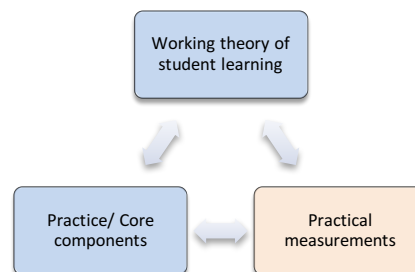
	PREWRITE: Write your own response and thinking about the question.	Helpful Sentence Frames <ul style="list-style-type: none"> • I think that _____ happened because... • I know _____ and that helps me better understand... • The activity we did with _____ helps me know more about _____ because... • One thing I'm wondering about is...
	Partner A tells Partner B his/her idea or response.	"Today I saw <u>(evidence)</u> . This supports/refutes my hypothesis about/that _____ because..."
	Partner B asks Partner A to explain their reasoning for how that evidence connects to the answer with more details.	<ul style="list-style-type: none"> • "Would you explain your reasoning in more detail?" • "Would you tell me why you think that using some evidence from class activities?" • "I hear you saying your evidence is _____." • "The reasoning that connects your evidence to the hypothesis is _____."
	Partner A answers B's questions.	
	Partner B responds.	"That is similar to my idea in that _____ AND my idea is different because _____."
	Write about what you have added to or changed about your initial ideas.	<ul style="list-style-type: none"> • My idea about _____ changed when my partner said... • I will add _____ to my idea about _____ because... My partner told me about _____ which I can use as evidence for my idea about...

Identify talk for how/why reasoning (August 2015) www.ambitioussciencelearning.org



Practical measurements

As a network of middle and high school science department teams, we are aiming to improve students' written and spoken scientific explanations, models and arguments. One of the discourse practices school teams have named and worked on improving is *equitable talk for how and why reasoning*. Following is an overview of the practical measures teachers and coaches use to inquire into the practice, the conditions under which the practice works best and for whom?



Structured talk is used to address issue of equity and rigor in classroom talk. There are several ways teachers can study this practice and systematically collect improvement data.

Exit ticket. Teachers use the following exit ticket with this practice. It is best to use the exit ticket right after a lesson with structured talk for how and why reasoning. This can be used for a short period of time (2 weeks) intensely to see if students' begin to experience the practice differently, or used across a longer period of time (for example surveying students twice in each unit of instruction across a school year).

You will need to have conversations with students about what each of the items mean so that students can begin to understand what, for example, “disagreeing” means. This will help you trust the data you receive back from students. Also, sharing this data with students can send the message that these items are important for a thoughtful and productive classroom culture.

Student Exit Ticket

1. Question(s) related to the content of the day's lesson. Adaptable: Some have used “Describe one thing that you understand better or differently after talking with your classmate(s).”

2. When you talked with your classmate(s), which of the following did you do? (check **ALL** that apply)

- | | |
|---|---|
| <input type="checkbox"/> I shared my idea | <input type="checkbox"/> I added on to a classmate's idea |
| <input type="checkbox"/> I shared an idea I wasn't sure about | <input type="checkbox"/> I explained why I disagreed with a classmate's idea |
| <input type="checkbox"/> I listened to a classmate's idea | <input type="checkbox"/> I used scientific evidence to support my idea |
| <input type="checkbox"/> I repeated or revoiced a classmate's idea to make sure I understood it correctly | <input type="checkbox"/> I used a sentence stem to explain my idea |
| <input type="checkbox"/> I described similarities and differences between my and my classmate's ideas | <input type="checkbox"/> I changed my idea after talking with my classmate(s) |
| <input type="checkbox"/> I asked a classmate a question | <input type="checkbox"/> Other _____ |
| <input type="checkbox"/> I explained why I agreed with a classmate's idea | |

3. What went well in your discussion? What do you think could have gone better? (We're looking to improve talk in class, so honest feedback will help us all!)

Data Snap Tool. The data snap tool on the next few pages is a planning and reflection tool for individual teachers to use or teachers working with coaches. The tool is modeled off of a PDSA (Plan-DO-Study-Act) cycle used in improvement science.

EQUITABLE SCIENCE TALK DATA SNAP TOOL

Name _____ Date _____ Class Period _____
 Science lesson topic _____

PLAN the lesson:

1) What is the purpose of the talk planned for this lesson?

2) What, if anything, are you changing about the talk opportunities from last time? What do you hope these changes will do?

3) Who is trying the practice?

- Teacher
- Teacher + Coach
- Teacher + Coach + Colleagues

4) How often have students engaged in this kind of talk in your class?

- This is the first time
- Tried it 1-2 times before
- Tried it 3-5 times before
- This is done regularly in my class 1-2x/week
- This is done regularly in my class 3-5x/week
- We practice this kind of talk daily

5) **PLAN** your question(s):

ANTICIPATE what you might hear in student reasoning at different levels:

What:

How:

Why:

DO the lesson: Consider the practices used, and collect talk data.

6) Which non-negotiable aspects of equitable science talk were in play in the lesson?

- Talk turns are structured and specific roles are explicit for students
- Structured talk in science asks students to extend beyond “what level” explanations
- Each student is required to share their own thinking
- Talk is open-ended and encourages students to share multiple responses

7) Which of the following ideas from the network were in play in this lesson? (check all that apply and add any new ones)

Revising models

- Prepare for the work of modeling
Prepare a causal, evidence-based explanation of the central phenomenon, go through the modeling process yourself before you ask students to do so
- Press students toward “how” and “why”
Give examples/exemplars of solid explanations, provide space and conventions on the model for incorporating explanatory (how and why) ideas and evidence as well as questions and tasks that prompt how/why writing, develop back-pocket questions to push students towards comprehensive how and why explanations, create strong connections between the entry task and the lesson (frame the lesson in the why or focus students on analyzing or comparing and contrasting parts of their models), encourage students to move back and forth between the what and how/why during model revision, give students “the what”****
- Engage students in connecting ideas
Provide access to materials from previous activities and prompts to help students remember science ideas, ask students to use evidence in their models, return to the specific phenomenon under consideration*, use different representations of a phenomenon to bring observables and unobservables together, provide students with opportunities to juxtapose ideas*, ask students to apply ideas to a new scenario**

Evaluating/using evidence

- Help students recognize evidence, hypotheses, and distinguish among them
Identify and elevate different student-generated hypotheses through focused discussion, provide evidence for students to use in brief written form (what we’ve called “evidence cards”), clarify what counts as evidence*
- Use structures that help students evaluate evidence in relation to hypotheses and use evidence in explanations
Use a writing format that emphasizes evidence (e.g., CER structured, TIED, etc.), provide explanation sentence frames as starting points, use worksheets that help students organize how hypotheses and pieces of evidence relate to each other, use a summary table for the phenomenon***
- Frame hypotheses and explanations as changeable in the face of evidence
Give students explicit permission to change their

<ul style="list-style-type: none"> Focus students on key science ideas <i>Create an explanation checklist****, clarify important ideas through targeted just-in-time instruction, have students engage with science texts and use ideas from readings</i> Have students track how their thinking has changed over time <i>Highlight revised explanations on their models</i> Provide access to modeling for all students <i>Create shared experiences for the model, make drawing and writing conventions for models explicit (arrows, zoom-ins, labeling molecules, etc.)*, ensure the model has multiple access points and paths to completion (e.g., some students may take on the whole model, whereas others may focus on a particular part), engage in science theater for “unobservables,” give students time to talk before writing, make students experts on particular parts of the model, use a “story” format to make writing an explanation more accessible</i> 	<ul style="list-style-type: none"> <i>hypotheses* or to edit/merge hypotheses based on evidence</i> Provide access to evaluating/using evidence for all students <i>Let students choose which hypotheses to investigate, have students work together on small chunks (e.g., a single evidence card at a time), display evidence and hypotheses publicly, give students manipulatives when weighing hypotheses* and visual supports for evidence and hypotheses, invite students to include experiences from past activities and their own lives</i>
<p>Supporting equitable student-student talk for how/why reasoning</p> <ul style="list-style-type: none"> Scaffold talk norms in the classroom <i>Provide and engage students in using sentence stems for different kinds of science talk (e.g., asking questions, agreeing or disagreeing – post on wall, hand out laminated cards, etc.), develop class norms for students listening to each other’s ideas*, model the kind of conversation you expect**, use structured talk to practice certain kinds of talk, allow students to leverage debate-oriented discourse</i> Create accessible, meaningful science contexts for students to work together <i>Create and root conversation in shared experiences, ask open-ended questions, have students work on a joint model, launch with multiple choice questions* or stepping stones toward the main work, keep the talk anchored in authentic science, limit talk time for less meaty questions</i> Provide adequate processing/sharing time <i>Group students according to processing time, give students private think/write time prior to talking, chunk work into manageable segments*, use a timer to moderate turns*, have options for “fast finishers”</i> Structure participation in partner talk, small groups, and whole-class share-out PARTNER/GROUP: <i>When students work in pairs, have one student talk and the other record, then switch, share directions and engage students in a structured talk protocol and explain why you’re using it*</i> SHARE-OUT: <i>Have students share their partner’s idea*, have students share and discuss their drawings with the class*, create a public record of shared ideas using students’ names** (and without evaluating the ideas), require students to write their initial ideas and how their ideas changed in preparation for sharing, intentionally sequence the share-out, have one group share and limit other groups to agreeing/disagreeing</i> Have students reflect on their engagement in talk <i>Analyze good videotaped conversations together, engage students in self-monitoring or providing feedback</i> 	<p>Supporting language development</p> <ul style="list-style-type: none"> Scaffold academic reading and writing <i>Support phenomenon-related vocabulary development (e.g., living word wall), include visualizations and manipulatives with explanations and complex tasks, model how to build sentences with sentence fragments/words, create sentence frames for particular tasks, provide some written pieces so students focus their writing on the most important cognitive work, use text cards with photos and parallel structure to help students find relevant information in text</i> Identify and plan support for EL students <i>Differentiate questions for different levels, intentionally pair students to support language use and development, allow students to confer with partners before sharing, pre-select students to share and let them know so they can practice/prepare</i> Encourage multiple language use <i>Provide or have students write materials in their language*, use 1st and 2nd languages with partners*</i>

Learnings from ACE, Cascade, Chinook, College Place, Evergreen, Highline, Rainier, and Renton

8) What-How-Why Data

	What: Student describes <i>what</i> happened. Student describes, summarizes, or restates a pattern or trend in data without making a connection to any unobservable/theoretical components.	How: Student describes <i>how</i> or partial why something happened. Student addresses unobservable/theoretical components tangentially.	Why: Student explains <i>why</i> something happened. Student can trace a causal story for why a phenomenon occurred or ask questions at this level. Student uses important science ideas that have unobservable/theoretical components to explain observable events.
What might this sound like today?			
Student 1: <ul style="list-style-type: none"> intermediate EL advanced EL not EL 			

Student 2: <input type="radio"/> intermediate EL <input type="radio"/> advanced EL <input type="radio"/> not EL			
Student 3: <input type="radio"/> intermediate EL <input type="radio"/> advanced EL <input type="radio"/> not EL			
Student 4: <input type="radio"/> intermediate EL <input type="radio"/> advanced EL <input type="radio"/> not EL			

STUDY the lesson:

9) What did you learn from the data?

10) How well did the talk serve the intended purpose? What effects did any changes have? Were they as expected?

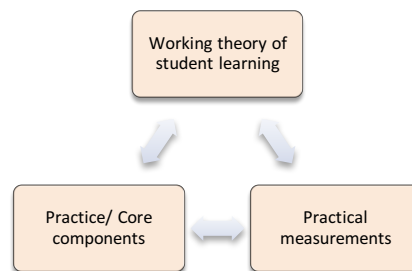
ACT

11) What might you try next time to better support students? (Are there any ideas you could use to improve the talk opportunities?) What new questions came up?

CASE STUDY: Learnings from teams of teachers in the network

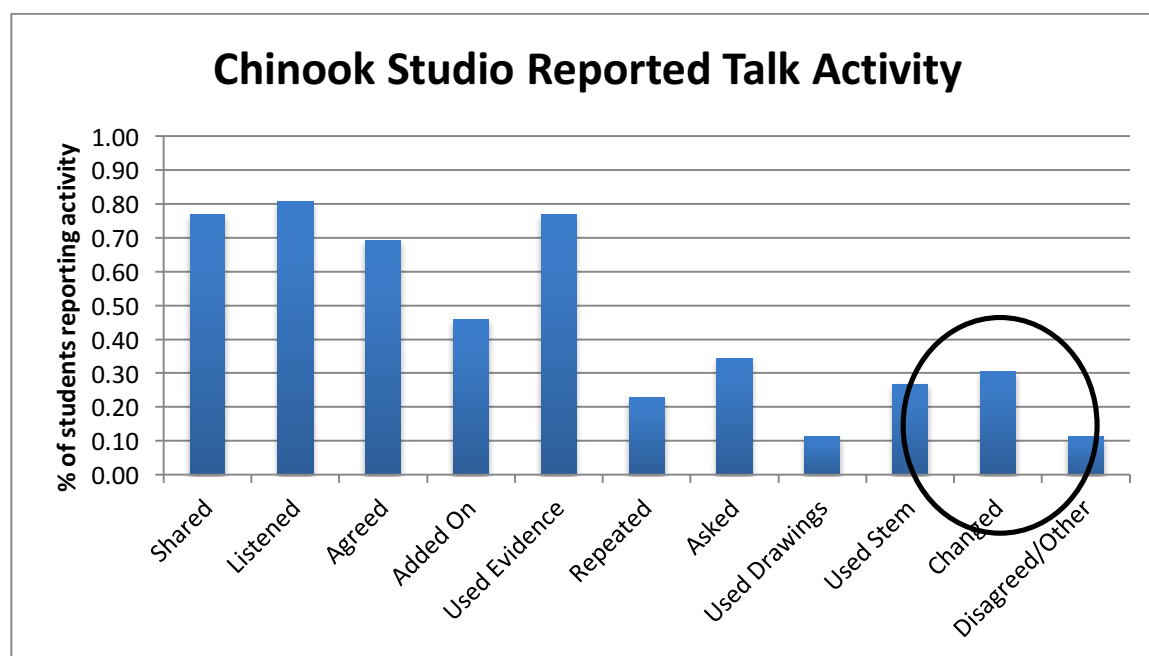
In this case study we describe how three schools, working on the same practice inquired into the practice and supported student learning. They examined the conditions for the practice of *equitable talk for how and why reasoning* by collecting and analyzing data and reflecting on their assumptions about how students learn.

[Chinook: Modifying the structured talk protocol to support students in changing hypotheses](#)



Problem of practice

This year, teachers at Chinook Middle School have been supporting students in using structured talk to help them engage in richer reasoning to construct and revise evidence-based explanations. For over a year, teachers had invested in helping students to use evidence to choose among multiple student-generated explanations for scientific phenomena. At the team's February studio day, teachers engaged students in a structured talk protocol designed to support their reasoning regarding multiple hypotheses in a given unit. Teachers collected data from students both about their scientific thinking and about their self-reported behaviors, and they noticed that students very rarely reported on changing their thinking during class, a critical practice in working with multiple hypotheses.



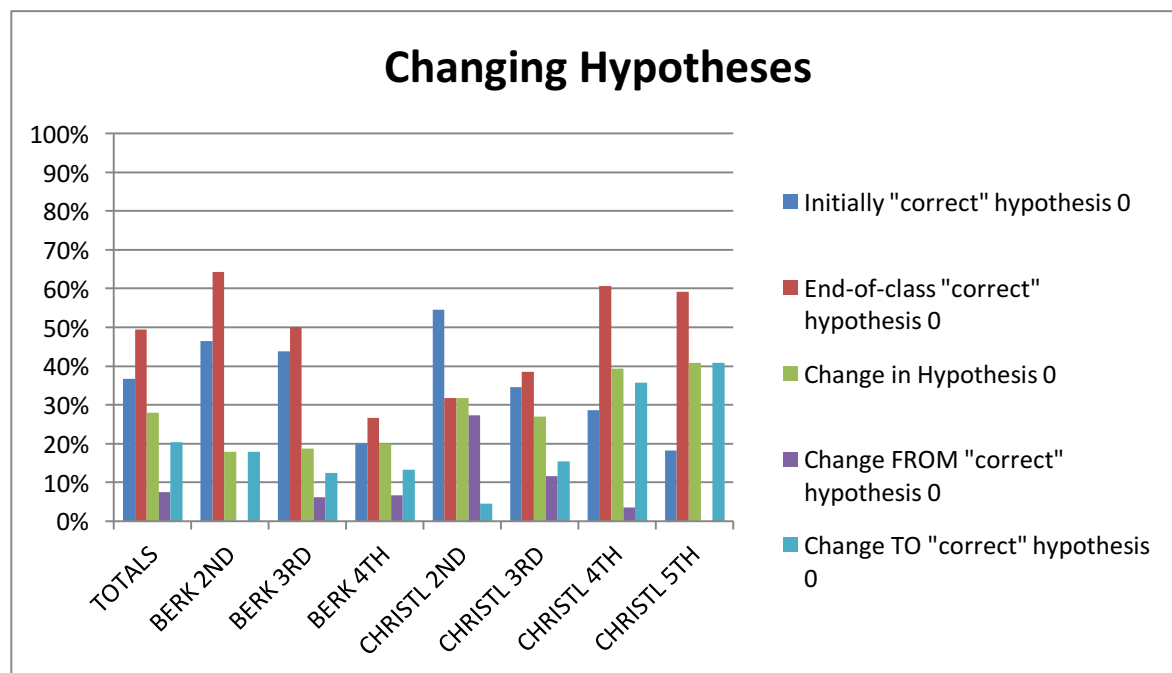
Small change

Teachers decided in a class a few weeks later to use a modified structured talk protocol (see below) that explicitly pushed students to share their reasoning in talk with one another AND to include some individual writing before and after the structured talk that asked students to focus on any changes in their thinking.

What worked? What did we learn? (How do we know?)

In this class with the modified structured talk protocol, we did NOT measure student-reported changes in thinking (something we later learned is usually higher than the percent of students who change their hypotheses from the beginning of class to the end). What we did investigate was actual hypotheses reported by students at the beginning of class compared to at the end of class.

We found that students changed their hypotheses from the beginning to the end of class roughly 25% of the time across 7 classes and 2 teachers. Overall, students tended to move from a less supported (and “less correct”) hypothesis to a more supported (and more “correct”) one. The one exception was one class in which students had a different interpretation of one of the hypotheses that was made public and caused students to shift towards this hypotheses.



For whom?

We found this shift in student thinking in all classes, including those with higher percentages of special needs and ELL students. However, the change in one of the higher special needs/ELL classes was lower than in some of the other classes. We also found that one teacher’s classes, in which there was more explicit talk from the teacher about changing, showed higher rates of change. And it was in that teacher’s class that the students shifted towards a more “incorrect” hypothesis when public discussion offered a different interpretation of that explanation.

Under what conditions?

The conditions for these changes were complex and included changes in teacher presentation of work, changes to the structured talk protocol (although we observed that students did not entirely adhere to the changed protocol and were a little loose in its implementation), and addition of more metacognitive writing both before and after the talk.

Wonderings and next steps





Teachers wondered whether public discussions could be too leading among student thinking (based on the disproportionate shift away from the more supported hypothesis in one class period). They also wondered about how to push the students further into deeper talk about their reasoning and how structured talk may or may not help that. And they wondered about what types of writing and reflection would best support student ability to reason more deeply and be open to changes in that reasoning over time.

Teachers engaged in two more rounds of structured talk changes in March and April to investigate this more thoroughly. They continued to adjust the talk protocol, the classroom instruction/messaging around changing of thinking, and opportunities to write and/or identify their interpretation of the best-supported hypothesis. Self-

reported changes in thinking continued to increase (from ~30% in February, to ~44% in late March, to ~60% in April). And by April, nearly 60% of students were showing changes in their hypothesis selection at the end of a class (compared to just under 30% in mid-March).

Teachers continued to wonder about how to get students to be more explicit about their reasoning and about changes other than the talk protocol that could support this.

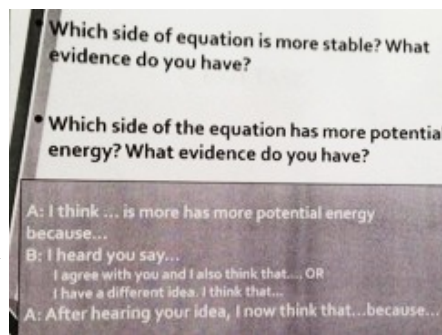
Modified structured talk protocol applied in March 2015

	PREWRITE: Students write independently their response to what will be the main question for discussion.	Questions might be something like: <ul style="list-style-type: none">Describe how one piece of evidence helps to answer the essential question and/or driving question (phenomenon).
	Partner A tells Partner B his/her idea/answer based on an activity, reading, or experiment we did in class (evidence).	“Today I saw <u>(evidence)</u> . This supports/refutes my hypothesis that _____ because _____”
	Partner B identifies the evidence used by Partner A. Partner B asks Partner A to explain their reasoning for how that evidence connects to the answer with more details.	“I hear you saying that your evidence is _____.” “The reasoning that connects your evidence to the hypothesis is _____.” OR “can you explain your reasoning with more details?”
	Partner A answers the question.	
	Partner B responds by saying, “That is similar to my idea in that _____, AND my idea is different because _____.”	
	Students write about how they have added to and/or changed their initial ideas.	

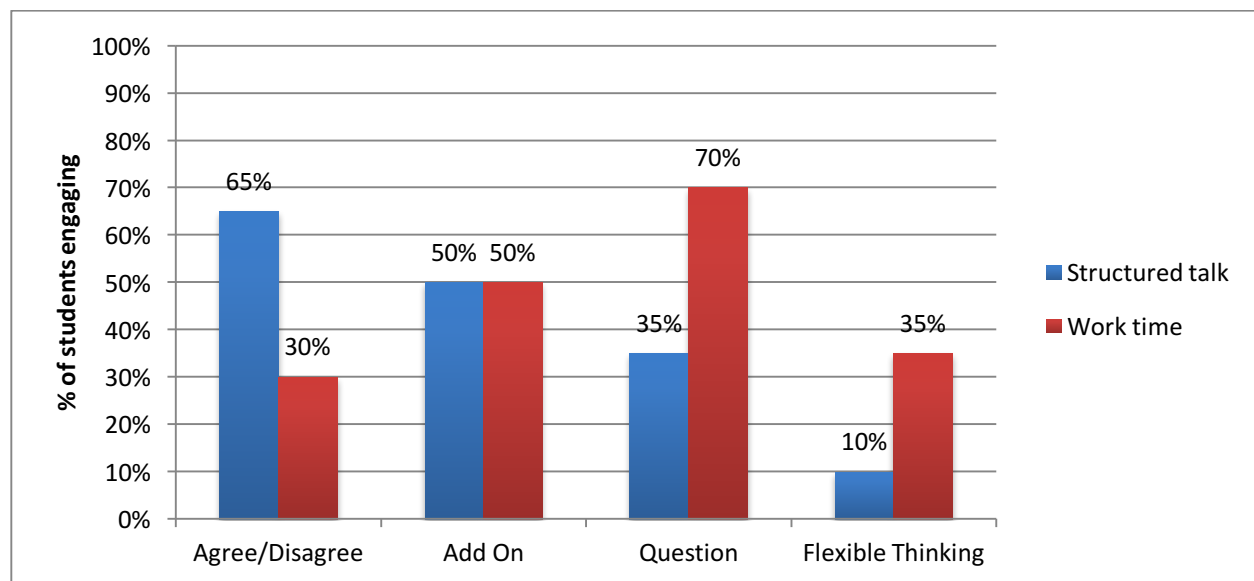
Evergreen: Comparing the kinds of talk occurring under two conditions

At an Evergreen studio day in May 2015, we decided to collect data on the kinds of talk students engaged in under two conditions:

- Structured talk opportunities designed to help students more fully articulate their agreement or disagreement with a partner's idea
- Group work time when students were working on joint worksheets



The graph below shows the results from one class period:



We interpreted the red columns to be more representative of the students' natural discourse patterns, and we saw that we were able to shift these patterns by providing explicit instructions and prompts to focus on agreeing and disagreeing during structured talk. This demonstrated that structured talk supported student engagement in particular kinds of talk – including kinds of talk that students were less naturally inclined toward.

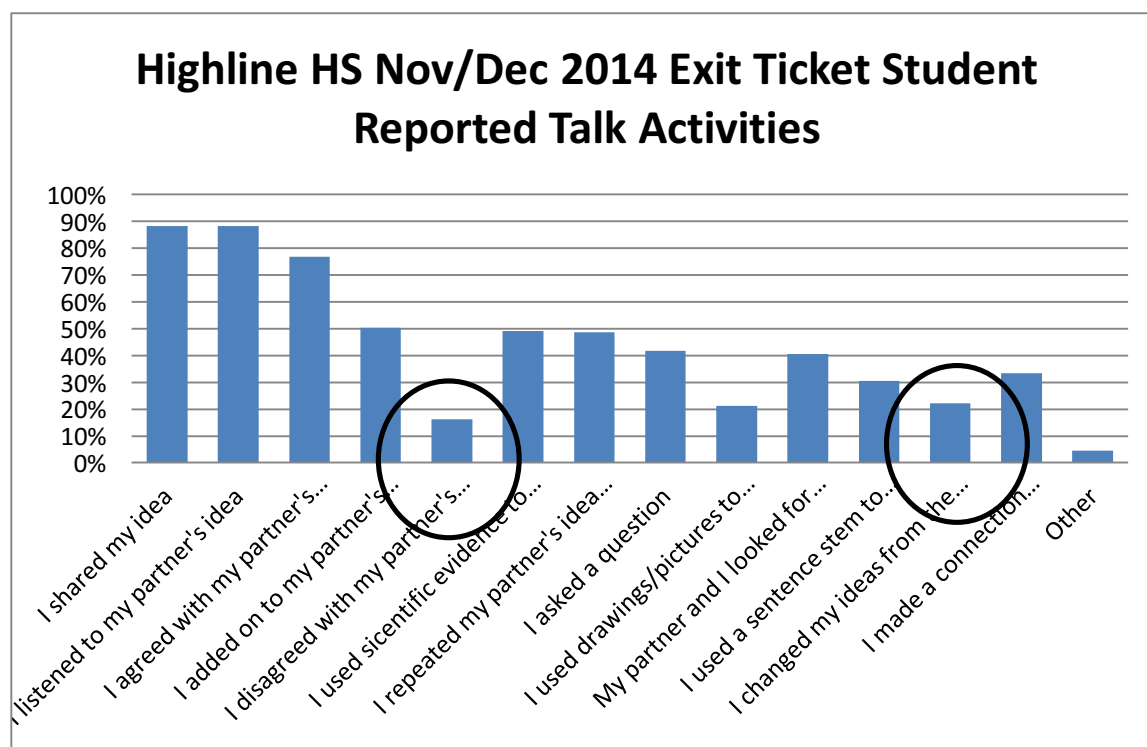
However, in the other class we taught the same day, we saw less of each kind of talk during structured talk than during work time. This raised questions for us about the effectiveness of structured talk, and for whom? (For instance, we did not track *who* talked during structured talk, work time, or both, but teachers reported that some students only talked during structured talk.) We also wondered if the structured talk opportunities supported deeper work time talk, which we could explore in the future.

Highline: Focusing on challenging and changing ideas

Problem of practice

This year, teachers at Highline High School have continued work they began at the end of last school year—using structured talk to help students engage more deeply with reasoning about evidence. Last spring, the teachers constructed a protocol to help encourage each student to both share and listen to different ideas about particular questions they were asked to consider during class. Teachers were generally happy with students having opportunities to talk, but they were still not seeing the depth of evolution of ideas and building on each other's thinking that they had hoped for. So this fall, teachers decided to investigate more deeply to see what sorts of talk activity students reported engaging in. They collected data from over 200 students in classes of five different teachers and found that the two lowest reported activities were disagreeing with a partner's idea and changing

their own ideas. Recognizing the need for students to evolve their thinking, teachers put some intentional efforts into helping students to recognize the importance of being able to change their own and their partner's thinking over the course of a unit of study.

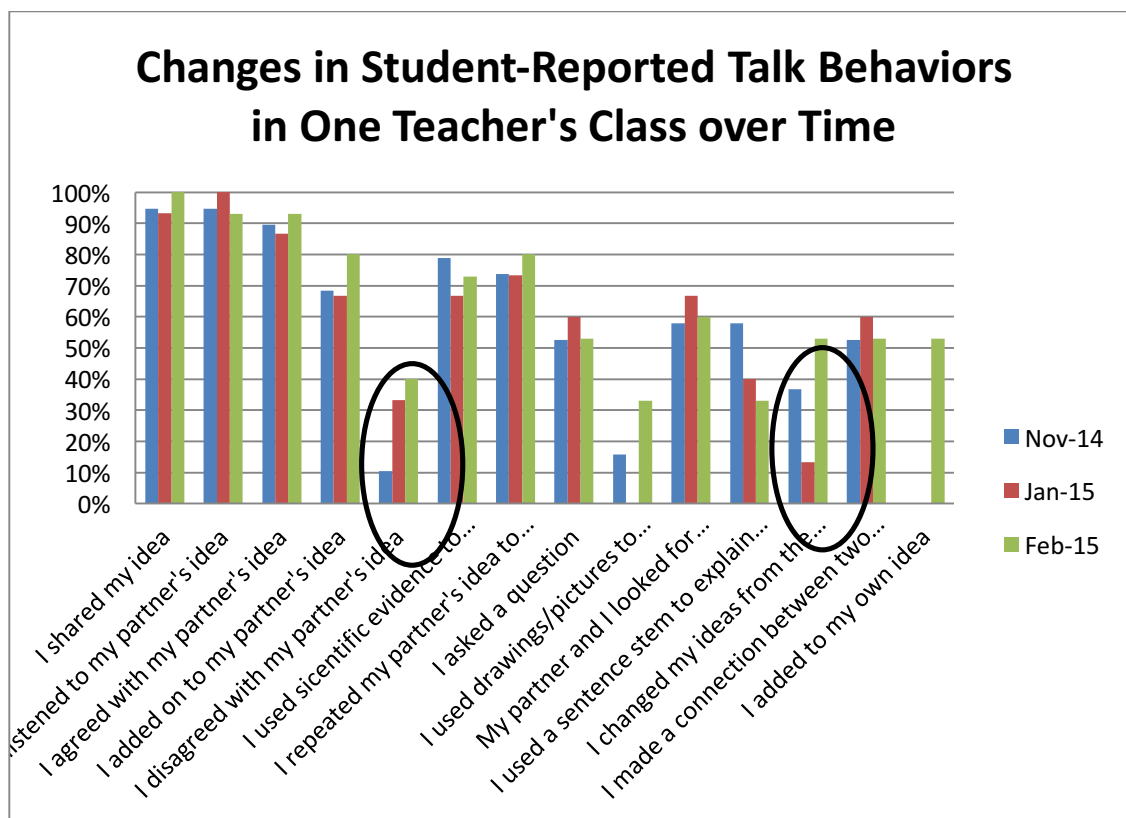


Small change

Teachers this year explored a variety of ways to couple structured talk with writing focused on the use of evidence and associated reasoning. In a studio day in February, one teacher first gave students a very structured claim/evidence/reasoning sheet to use after episodes of talk. She continued to work on ways to couple structured writing with the structured talk over time, and ended up with a sheet that asked students to draw representations of their partner's ideas and to show how their own ideas had changed. She collected exit ticket data a few more times over the course of this work. Additionally, another teacher independently worked on using writing during the course of structured talk to help students better prepare and change their ideas before and after discussion. In most cases, teachers coupled these modifications with instructions to students that changing their thinking and questioning partner's ideas were important things to do.

What worked? What did we learn? (How do we know?)

In looking at just one of the first teacher's classes over time, we found a net increase in both challenging partner's ideas and changing their own ideas. We also saw significant written responses submitted by students on the written work. Note that in the second data point, the structured writing did not yet ask the students to describe changes in their thinking, but that change was in place for the third data point.



For whom?

Our analysis did not identify whether students came from particular groups. However, the class studied was one with many struggling students, and anecdotal evidence suggested some positive changes for students. Additional data collection over time can help elucidate this further.

Under what conditions?

The conditions for these changes were very complex and included changes in teacher presentation of work, very pointed activities to help focus students on applying particular evidence to explanations they were constructing, and substantial evolution of claim/evidence/reasoning and other structured writing sheets. Exit tickets were not used every time but were analyzed at a few points.

Wonderings and next steps

Teachers continued to wonder how to further deepen students ability to reason with evidence and continued to explore coupling the talk and written protocols as well as ways of helping students recognize and discuss evidence.

Teachers seemed to converge on their wondering about how to get students to be more explicit about their reasoning and about changes other than the talk protocol itself that could support this.

Making connections to Danielson and NGSS

Although equitable science talk as a practice itself is not called out specifically in the Danielson Framework or in the Next Generation Science Standards (NGSS), it relates to many of the principles and practices represented in both. Following are some points of relevance/overlap. This is not a comprehensive set of connections; rather, it highlights some of the most relevant connections.

CONNECTIONS TO DANIELSON FRAMEWORK

Danielson Domain	3a: Communicating with Students	3b: Using Questioning and Discussion Techniques	3c: Engaging Students in Learning
Relevant quotes from domain description	<p>"[Teachers] provide clear directions for classroom activities, so that students know what it is that they are to do."</p> <p>"Teacher presents complex concepts in ways that provide scaffolding and access to students."</p> <p>"Students are clear about what they are expected to do during a lesson, particularly if they are working independently or with classmates, without direct teacher supervision."</p> <p>"The teacher...and explains procedures and directions clearly."</p> <p>"...the directions and procedures are clear and anticipate possible student misunderstanding;"</p>	<p>"...it is important that questioning and discussion are used as techniques to deepen student understanding."</p> <p>"Good teachers use divergent and convergent questions, framed in such a way that they invite students to formulate hypotheses, make connections, or challenge previously held views."</p> <p>"High quality questions encourage students to make connections among concepts or events previously believed to be unrelated, and arrive at new understandings of complex material."</p> <p>"Effective teachers also pose questions for which they do not know the answers."</p> <p>"In order for students to formulate high-level questions, they must have learned how to do so."</p> <p>"...[teacher] asks the students questions designed to promote thinking and understanding."</p> <p>"Teacher uses open-ended questions, inviting students to think and/or offer multiple possible answers."</p> <p>"discussions enable students to talk to one another without ongoing mediation by the teacher."</p>	<p>"...[students] are engaged in discussing, debating, answering 'what if?' questions, discovering patterns, and the like."</p> <p>"The best evidence for student engagement is what students are saying and doing as a consequence of what the teacher does, or has done, or has planned."</p> <p>"Keeping things moving, within a well-defined structure, is one of the marks of an experienced teacher."</p> <p>"Learning tasks have multiple correct responses or approaches and/or demand higher-order thinking."</p> <p>"Virtually all students are intellectually engaged in challenging content through well-designed learning tasks and suitable scaffolding by the teacher and fully aligned with the instructional outcomes."</p>
Examples of what this may look like in the classroom	<p>Protocol on poster to provide directions for how to do structured talk</p> <p>Teacher models the protocol for students</p> <p>The purpose of the structured talk is explained to students</p>	<p>Students are given adequate quiet time to process their ideas prior to doing the structured talk</p> <p>Students are asked to do something with the two ideas shared - compare/contrast, agree/disagree, find evidence to support/refute</p> <p>Students use a variety of questions (perhaps provided by teacher) to sustain the conversation and/or to go deeper (increase the rigor)</p>	<p>Students use options to sustain the conversation if "finished" such as asking each other more questions, engaging other groups in similar conversations, writing new ideas down</p> <p>All students are expected to participate and held accountable</p>

CONNECTIONS TO NGSS PRACTICES

NGSS Practice	Relevant Quotes from Practice Description
1. Asking questions (for science) and defining problems (for engineering)	<p>"Students at any grade level should be able to ask questions of each other about the texts they read, the features of the phenomena they observe, and the conclusions they draw from their models or scientific investigations."</p> <p>"Scientific questions are distinguished from other types of questions in that the answers lie in explanations supported by empirical evidence, including evidence gathered by others or through investigation."</p> <p>"Asking questions and defining problems also involves asking questions about data, claims that are made, and proposed designs."</p>
6. Constructing explanations (for science) and designing solutions (for engineering)	<p>"An explanation includes a claim that relates how a variable or variables relate to another variable or a set of variables. A claim is often made in response to a question and in the process of answering the question, scientists often design investigations to generate data."</p>
7. Engaging in argument from evidence	<p>"...students should argue for the explanations they construct, defend their interpretations of the associated data, and advocate for the designs they propose..."</p> <p>"Whether investigating a phenomenon, testing a design, or constructing a model to provide a mechanism for an explanation, students are expected to use argumentation to listen to, compare, and evaluate competing ideas and methods based on their merits."</p>
8. Obtaining, evaluating, and communicating information	<p>"Communicating information, evidence, and ideas can be done in multiple ways: using tables, diagrams, graphs, models, interactive displays, and equations as well as orally, in writing, and through extended discussions."</p>