THE SANDWICH STRATEGY

NO MATTER HOW YOU SLICE IT, ANALYZING STUDENT WORK TOGETHER IMPROVES MATH INSTRUCTION

By Lynsey K. Gibbons, Rebecca M. Lewis, and Lisa Nguyen Batista

Teachers are regularly asked to use data to inform their instruction. In the past, teachers examined student work in isolation (Little, Gearhart, Curry, & Kafka, 2003). Now, however, teachers increasingly have dedicated meeting times. So how can teachers collaboratively examine student work and use their findings to improve instruction?

A team of teachers at Hilltop Elementary School in the Pacific Northwest demonstrates the power of collaborative analysis of student work as teachers and school leaders use student work to guide their instructional decisions and support their professional learning about teaching mathematics.

Hilltop Elementary is an urban school that serves an

GRADE 3 COMMON CORE STATE STANDARDS FOR FRACTIONS

3.NF.1: Understand a fraction 1/b as the quantity formed by 1 part when a whole is partitioned into *b* equal parts; understand a fraction *a/b* as the quantity formed by a parts of size 1/*b*.

3.NF.2: Understand a fraction as a number on the number line; represent fractions on a number line diagram.

3.NF.3: Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

Source: www.corestandards.org/Math/Content/3/NF.

ethnically and linguistically diverse population, as well as high poverty and mobility rates. Over 50% of the student population speaks a language other than English at home.

Teachers and school leaders at Hilltop hold a deep commitment to knowing each student and creating classroom communities that provide rich learning opportunities. Part of their collective vision for mathematics instruction is to listen carefully to how students are thinking and use those observations to make instructional decisions that support students to advance their ideas.

In the following vignette, we examine the types of conversation that take place while teachers and school leaders collectively examine student work to inform instruction.

Tara Lee, the mathematics coach, is facilitating the work of the team of three 3rd-grade teachers, an English language learners specialist who supports 3rd graders in their classrooms, and the principal as the group examines a formative assessment task, considers students' current thinking against the Grade 3 Common Core State Standards for Fractions (see above), and discusses the implications for their upcoming fractions unit.

All of the teachers bring student work from a task they had used and interviewed their students about the previous week (see examples on p. 16). The task asked students to determine how six students can share eight sandwiches equally. The group breaks into smaller groups to look across the student work, 67 pieces in all.

As you examine the student work, notice how students partitioned the sandwiches and answered how many sandwiches an individual child receives — both their written notation and what they said, which was recorded by the teacher off to the side using quotation marks.

Lee: Now that we've looked at the standards, let's take a few minutes to look at the student work from last week's formative assessment. As you look through the work with a partner, pay attention to how students partitioned the sandwiches, their use of fraction language, and their use of fraction notation.

As the two small groups analyze the student work, Lee spends time with each. In one group, Ana Seiw, the English language specialist, has joined two 3rd-grade teachers, Christine Clint and Aretta Wilson.

Clint: Look how many kids were able to partition and share the sandwiches fairly. I wasn't expecting that.

Wilson: That surprises me, too, and they aren't all partitioned the same way. For example, Franklin split all the sandwiches into sixths and Marisol split all the sandwiches into thirds.

Seiw: And a few kids, like Abdi and Abna, shared whole sandwiches first and then partitioned only the two that are leftover. What did these kids do last year in 2nd grade with fractions?

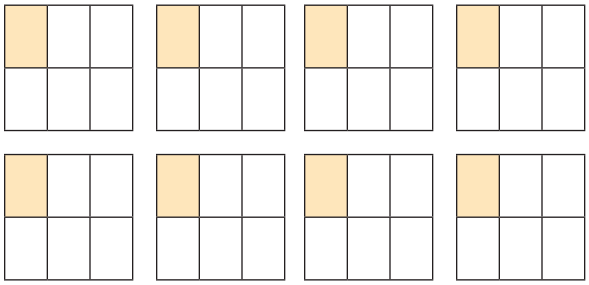
Lee: They had lots of opportunities to partition both circles and rectangles. It's part of the 2nd-grade geometry standards.

In the other group, principal Julie Richards and 3rd-grade teacher John Soren flip through the same set of student work.

Richards: This is interesting. There are a handful of students who seem to use the term "half" to name any piece that's smaller than a whole.

Soren: I noticed that, too. And some kids don't use any fractional language at all. Franklin and Marisol both count up the number of pieces, regardless of their

6 children are sharing 8 sandwiches



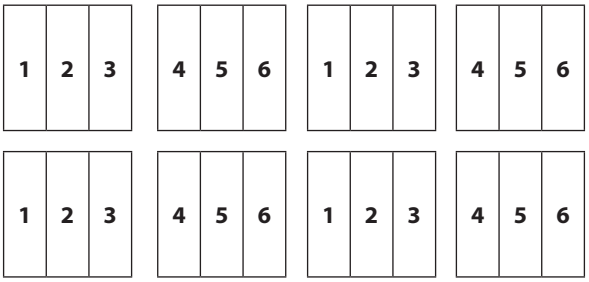
FRANKLIN'S WORK

NAME: Franklin

6 children are sharing 8 small sandwiches.

They are sharing so each child gets the same amount.

How many sandwiches will one child get? **8 sandwiches**



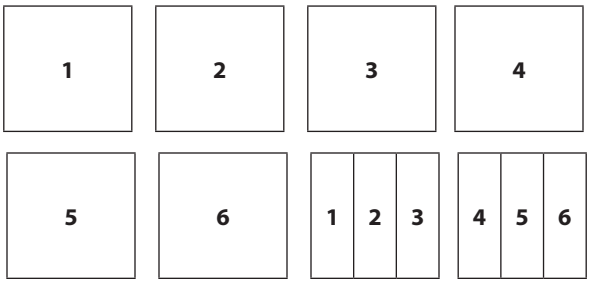
MARISOL'S WORK

NAME: Marisol

6 children are sharing 8 small sandwiches.

They are sharing so each child gets the same amount.

How many sandwiches will one child get? **4** ("4 pieces")



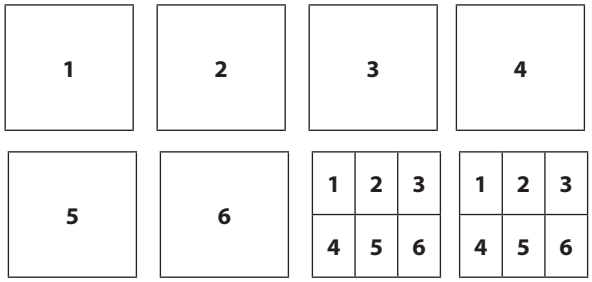
ABDI'S WORK

NAME: Abdi

6 children are sharing 8 small sandwiches.

They are sharing so each child gets the same amount.

How many sandwiches will one child get? **1 and ½** ("a whole and a half")



ABNA'S WORK

NAME: Abna

6 children are sharing 8 small sandwiches.

They are sharing so each child gets the same amount.

How many sandwiches will one child get? **½ sixths** ("one and two sixths")

size, but they use different labels for their answers. Marisol calls them pieces, and Franklin refers to the whole sandwich.

Richards: It also seems like writing the fraction is tricky. Abdi represented his ideas with notation, whereas others, like Abna, can say the fraction name, but they aren't sure how to write it using symbolic notation.

Lee brings the whole group back together and asks, "What did you notice?" She records their comments on chart paper (see p. 17). Before asking teachers to consider instructional implications, Lee introduces a short reading from mathematics education research about fraction terminology and symbolic notation (Empson & Levi, 2011, pp. 24-26).

Based on her knowledge and experience of students' reasoning in fractions, Lee had anticipated that these ideas would be important for teachers to consider. The group's conversation about the reading proceeds.

Soren: Reading this feels reassuring about where our students are at currently. Like the part about many kids overgeneralizing "half" because fraction terminology isn't intuitive.

Wilson: I was surprised to read the recommendation about waiting to introduce symbolic notation, but it makes sense. Notation can be one of the hardest things for kids to learn about fractions.

Seiw: I was surprised by the recommendation to focus on the size of the part relative to the whole, like describing something as a one-eighth size piece rather than one out

TEACHERS' ANALYSIS OF STUDENT WORK

WHAT WE NOTICED	INSTRUCTIONAL IMPLICATIONS	WE COMMIT TO ...
• Most students can partition and fair share (in lots of ways). • The term "half" is overused. • Some students don't use fractional language at all. • Symbolic notation is challenging.	• Ask students: "How many of these parts fit into the whole (sandwich)?" to reinforce relationship between size of piece and whole. • Use language such as "sixths-sized pieces." • Introduce "word notation" first (e.g. "three-eighths"); then introduce symbolic notation.	• Beginning the unit with five days of sharing problems plus daily whole group discussion. • Lee joining each class for one or more day(s) of sharing problems. • Bringing to PLC the following week: - Tracking student understanding on clipboard; and - A common (across classes) exit ticket every Wednesday.

of eight. It seems like we should think about how to be consistent with our questions and our language in order to make the meaning more explicit.

Richards: I agree. What language can we all agree to use across all of our classrooms?

Lee: Yes, and I'm also wondering how we can support students in moving toward using accurate symbolic notation for fractions.

Having collectively identified fractional language and symbolic notations as goals for student learning, Lee asks the group to consider implications for their instruction. The teachers draw on their experiences and the suggestions from the reading. In the final few minutes of the meeting, Lee asks the group, "What commitments do we want to make as we begin our fractions unit?" They make decisions related to task selection, coach support, and data collection (see above).

In this collaborative meeting, the teachers examined student work that was generated from an equal sharing problem posed to students *before* the beginning of their fractions unit. This preassessment item, along with the one-on-one conversations that teachers had with students about the item, allowed teachers to gather information about students' current understanding of the meaning of fractions, which then informed their unit planning in response to the data.

The student work and teachers' notes provided opportunities for teachers to explore how students were partitioning, as evidenced by the ways in which they "cut" the sandwiches (e.g. in thirds or sixths), their use of fraction language (e.g. "pieces," "one-third," or "two-sixths"), and the symbolic notation they used to represent their fraction (e.g. 1⅓ or 8/6).

The teachers found, as they looked across all the 3rd graders, that a majority of students were able to partition and share fairly but were uncertain about how to name the fraction using words and symbolic notation. Following the analysis of the student work, the coach supported teachers to identify a common language for supporting students to name fractions and use symbolic notation during instruction.

Teachers also considered the kinds of instructional activities to use and discussed potential common formative assessments to evaluate the progression of students' understanding and strategies across the unit.

Later, two weeks into their fractions unit at another teacher collaborative meeting, the group reflected on the decisions they had made based on their analysis of student work. Here is a summary of the conversation that took place after Lee asked, "How is your fractions instruction going? What have we learned about teaching fractions?"

Soren: Starting with the equal sharing problems was really powerful. I was able to monitor students' progress regularly with regard to their partitioning strategies and their use of fraction language and symbolic notation.

Clint: I felt that the whole-group discussions I had with my class were really important. I was so glad that we spent time agreeing on the language we wanted to use in our classrooms. At first, the language felt awkward, but with practice, it felt more natural for me and the kids.

Wilson: I was a little nervous about delaying the symbolic notation as we had agreed to try when we first talked about it. But I am noticing that my students this year are using symbolic notation with more accuracy than in the past.

Here, teachers reported how their instruction changed as a result of their examination of student work, discussions with one another, and commitments to try new instructional strategies. Let's consider the conditions that can lead to productive collaborative discussions, particularly around examining student work, including school leaders' roles in supporting such discussions.

1. **The quality of student work matters.**

High-quality instruction includes teaching in response to students' current thinking. Teachers need to understand the content that students need to learn and how it develops along learning progressions (NCTM, 2014). As we saw in the vignette, examining student work can be a primary activity to

support teachers to learn about how students' understanding of particular disciplinary ideas develop over time (Carpenter, Fennema, & Franke, 1996).

The type of student work collected is important to consider. Many standardized and curriculum-embedded assessments simply indicate whether students got answers correct, but they do not help teachers understand what students think as they solve problems or what approaches they take (Lewis, Gibbons, Kazemi, & Lind, 2015).

Knowing *how* students arrive at their answers can help teachers make informed decisions to improve learning opportunities for students. Formative assessment tasks that are designed for teachers to confer with students about their thinking, such as the one on p. 16, are needed to help teachers learn about how students are reasoning. Talking with students about their strategy use can lead to more accurate interpretations and data on which to base decisions.

2. Examine student work collectively.

Certain conditions can be established to support teachers' collective examination of student work. It is essential that ongoing time be set aside to ensure that teachers come together to learn. At Hilltop, teachers' schedules were aligned so that they could meet twice a week —once to talk about mathematics instruction and another to talk about literacy instruction.

Examining student work collectively can also support the learning of educators across the organization. Common experiences enable successful collaborative discussions.

Examining student work collectively can also support the learning of educators across the organization. Common experiences enable successful collaborative discussions. When examining student work, teachers at Hilltop have benefited from giving the same formative assessment tasks to their students. By examining the same task given to all students across the grade level, teachers collectively deepen their understanding of how students reason about a particular idea.

As a result, they commit to trying out particular instructional activities with students, supporting each other to develop new practices. While teachers are responsive to students' needs, they try to stay on a similar pace with instruction so they can have ongoing conversations about their teaching and student learning. The school community is continually striving to improve mathematics instruction to strengthen student learning.

3. School leaders' participation is essential.

The principal has a critical role at the weekly collaborative meetings at Hilltop, working with teachers to analyze student work, understand student learning progressions, and participate with teachers to consider modifications to instruction.

Participating as a learner is important because principals are instructional leaders who are often asked to provide teachers feedback about their instruction. During the collaborative meetings, principals also have a role in monitoring what teachers are learning and pressing them to take up the agreed-upon instructional strategies. We see this in the above vignette, when the principal presses teachers to consider what they will commit to do across all of their classrooms.

Effective facilitation also means assisting teachers with connecting what they are uncovering about students' thinking with their instructional practices.

4. Effective coaching supports teacher learning.

An experienced instructional coach leads each collaborative meeting. At Hilltop, the math coach has built strong relationships of trust with her staff and engaged in learning opportunities to develop her own skills of facilitating adult learning.

In the vignette, we saw how the coach supported teachers' examination of student work and their subsequent conversations. She had particular goals for the teachers' learning and thus guided their attention toward particular aspects of the student work.

For example, as teachers began to look at the task, Lee asked teachers to "pay attention to students' partitioning strategies, their fraction language, and their use of notation." Consistently, the coach pressed teachers to consider what students did to solve the problem, why they solved it in particular ways, and what their strategies revealed about their understanding of fractions.

Another important aspect of the coach's work is to support teachers' learning by bringing in research on children's thinking and pedagogy. The coach asked teachers to review a reading authored by mathematics education researchers. In doing so, she supported teachers to learn about new forms of instruction, such as the instructional sequence for supporting students to learn fraction symbolic notation.

Effective facilitation also means assisting teachers with connecting what they are uncovering about students' thinking with their instructional practices. We saw this, in part, when she pressed teachers to consider instructional implications based on what they had learned from examining the formative assessment task.

Finally, the coach has an important role in helping teachers as they implement the agreed-upon instructional strategies in their classrooms. The coach provides valuable follow-up support through providing follow-up communication and resources regarding what teachers commit to do in their classrooms, and providing in-classroom support such as co-teaching as teachers implement equal sharing problems.

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on their practice would benefit the entire school system but that leadership was critical. Without organizational support, the research they cited showed that teacher collaboration made no difference.

As we deepen and extend our school-based learning through collaborative inquiry, we have to consider how we as central office staff can support teachers, system leaders, and administrators in creating and sustaining a culture of professional learning in our schools. Models like the collaborative inquiry/lab class model described here, with a combination of networked learning between schools at large-group sessions and small-group, in-school classroom observations, offer an option for engaging in purposeful professional learning. At our final meeting, a 3rd-grade teacher concluded, "Working together, we have learned that we have some common struggles, and we are able to learn from each other. We are more effective as a team."

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WORKING TOGETHER TO GET BETTER

We can best support student learning by teaching in response to students' current thinking. Supporting teachers' collective analysis of student work can be a powerful tool for informing and improving instruction.

The information gathered from a rich formative assessment task can support teachers' learning about how students come to know particular disciplines. With the support of a skilled instructional coach and their colleagues, teachers can take what they have uncovered about students' thinking and collectively make commitments to try instructional tasks and strategies that can be reflected upon later.

By examining student work together, the school community engages in conversations that support continuous improvement of instruction and student learning. Student data analysis is better together.

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