3 Grade 4

Who Needs Fractions?

Gisela Ernst-Slavit, Margo Gottlieb, and David Slavit

Fractions are the first place in children's experiences where a number represents something other than a count.

J. van de Walle (2001, p. 211)

CLASSROOM CONTEXT

Content:	Mathematics—Fractions
Grade:	4
Languages of the Students:	Spanish, Russian/Ukrainian, Vietnamese, Japanese, and English
Teacher Experience:	5 years, ELL Endorsed
School:	Grades K–5; Suburban NW U.S.; 50% free and reduced lunch; ethnically diverse

Amanda Thorne couldn't believe that she had been a fourth grade teacher for five years. Although she had graduated with a degree in elementary education, she soon felt ill equipped to work with the increasing numbers of English language learners (ELLs) who appeared at her suburban K–5 school. So she took the next logical step and enrolled in graduate school to become an endorsed teacher of English as an additional language. This

decision was fortunate for her and her students, because this year over half of Amanda's students are first- or second-generation immigrants who are second language learners.

Students

Each of the 28 students in this fourth grade class comes with a unique profile and distinct way of learning. While there is a smattering of European Americans and African Americans, other linguistically and culturally diverse students represent the majority of this dynamic class, reflecting the new demographic of the school. Although many of the students are impoverished economically, each brings a wonderfully rich cultural background to share.

Amanda provides academic language support to her seven ELLs, one of whom has special needs, and closely monitors two former ELLs. She has an eclectic mix of languages and cultures in her class. In her bustling classroom, seats around the tables are arranged so that the proficient English speakers serve as models and partners for the ELLs during interactive activities.

This year, Amanda has three Spanish speakers of Mexican heritage, three students who speak Russian, two Vietnamese speakers, and Yoshio, a recent arrival from Japan. Just last month, two of her students—Humberto and Oksana—met the state criteria for being reclassified as no longer needing language support. Even though they still struggle some, particularly with writing forms, both students have become excellent teaching buddies for their peers.

Selena, Carmen, Kim-Ly, and Giang are all at an intermediate level in English and are active participants in class. Amanda feels that her efforts need to focus on helping this group of students improve their reading comprehension and communicate the full range of their thinking in writing. She pays special attention to Selena, who has been diagnosed with a reading disability, following her individualized education program (IEP) to make sure that print input is always augmented by visual, auditory, and technology supports to maximize her opportunities to comprehend the mathematics concepts. In struggling with word recognition, spelling, and fluency in both Spanish and English, Selena displays classic dyslexic features. Amanda uses the same instructional strategies with Selena that she uses for her other ELLs, but in addition, she is careful to give Selena more time for processing and rehearsal of newly introduced words and expressions.

Two of the beginner ELLs, Sasha and Vadir, seem to be progressing nicely in picking up everyday English. And then, there is her newest addition, Yoshio, always very attentive, able to follow directions by looking at his peers, but yet hesitant to speak. Diep, Marisol, and Luis are

simultaneous bilinguals who have grown up in households with two languages and are fully proficient in both. Here is a chart that highlights the linguistic diversity of the class.

Home Languages and English Language Proficiency (ELP) Levels in Amanda's Classroom

English Language Proficiency Levels 1–2	*English Language Proficiency Levels 3–4*	*Recently Exited From Language Support*	*Proficient English Speakers From Linguistically Diverse Backgrounds*
Sasha (Russian/ Ukrainian) Vadir (Russian) Yoshio (Japanese)	Carmen (Spanish) Giang (Vietnamese) Kim-Ly (Vietnamese) Selena (Spanish)	Humberto (Spanish) Oksana (Russian)	Diep (Vietnamese) Luis (Spanish) Marisol (Spanish)

The class is about to be introduced to a new mathematics unit on fractions. Amanda and her fourth grade team carefully plan to bring to the forefront the language of mathematics every step of the way while keeping the students' sociocultural backgrounds and perspectives in mind.

UNIT THEME

In speaking with the other fourth grade teachers at their weekly joint planning meetings, Amanda confirms her belief that fractions are an important step in children's understanding of real numbers. Over the years, she and the fourth grade team have witnessed students struggle in two areas: getting their heads around the concept of fractions, and learning the language involved in working with fractions. As students are challenged both linguistically and conceptually with understanding and using fractions, Amanda thinks this topic would be ideal for creating some additional hands-on activities. Consequently, she expands the duration of the thematic unit to three weeks. Together, the fourth grade teachers design a common culminating activity around recipes, which serves as the basis for the unit's common assessment for all fourth grade classes. It is here where students have opportunities to demonstrate and apply their new mathematical knowledge, skills, and academic language.

In anticipation of starting the unit, Amanda begins the day by taking a deep breath. Her students are still reeling from having received their first piece of "gold"! Jonathan has just returned from visiting his grandparents in Brazil and brought each student a piece of iron pyrite—fool's gold. The

small rocks with their metallic luster and brass-yellow hue have sure made an impression on the kids. Although Amanda had prepared a variety of engaging activities to get her fractions unit started, she thought that nothing would top the excitement generated by those shiny rocks.

Where might Amanda begin to explore the topic of fractions so her students experience real-world applications? She knows this to be a very accessible and powerful unit of instruction and that she needs to rely on multiple resources. The most logical place to start planning is the chapter on fractions in the textbook adopted by the district (see excerpt below).

Excerpt 1, From *Everyday Mathematics*

Use of Fractions

The numbers $\frac{1}{2}, \frac{2}{3}, \frac{5}{4}, \frac{7}{1}$, and $\frac{25}{100}$, are all fractions. A **fraction** is written with two whole numbers that are separated by a fraction bar. The top number is called the **numerator**. The bottom number is called the **denominator**. The numerator of a fraction can be any whole number. The denominator can be any whole number except 0.

When naming fractions, name the numerator first; then name the denominator.

three-fourths $\frac{3}{4}$ → numerator → denominator → $\frac{25}{100}$ twenty-five hundredths

Fractions were invented thousands of years ago to name numbers between whole numbers. People needed these in-between numbers for making careful measurements.

Here are some examples of measurements that use fractions:

$\frac{2}{3}$ cup, $\frac{3}{4}$ hour, $\frac{9}{10}$ km, and $13\frac{1}{2}$ lb.

Fractions are also used to name parts of wholes. The whole might be one single thing, like a pizza. Or, the whole might be a collection of things, like all the students in a classroom. The whole is sometimes called the ONE.

Source: The University of Chicago School Mathematics Project, 2012, Level 4. Unit 7, p. 42.

Realizing that she will need to bring in additional genres or text types into her classroom to make the unit more meaningful and closer to life for her students, Amanda decides that everyday recipes from the students' homes and cultures would add interest and motivation. Amanda begins by choosing her family's favorite recipe, chocolate brownies, to share with her students.

A Complementary Thematically Related Text About Fractions

Scrumptious Chocolate Brownies

Serves 16

Ingredients

For the Brownies

- $\frac{1}{2}$ cup butter
- 1 cup white sugar
- 2 eggs
- 1 teaspoon vanilla extract
- $\frac{1}{3}$ cup unsweetened cocoa powder
- $\frac{1}{2}$ cup all-purpose flour
- $\frac{1}{4}$ teaspoon salt
- $\frac{1}{4}$ teaspoon baking powder

For the Frosting

- 3 tablespoons butter, softened
- 3 tablespoons unsweetened cocoa powder
- 1 tablespoon honey
- 1 teaspoon vanilla extract
- 1 cup confectioners' sugar

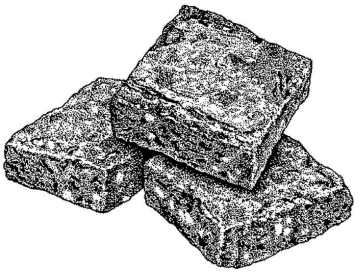
Directions

Preheat oven to 350 degrees F (175 degrees C). Grease and flour an 8 inch square pan.

In a large saucepan, melt $\frac{1}{2}$ cup butter. Remove from heat, and stir in sugar, eggs, and 1 teaspoon vanilla. Beat in $\frac{1}{3}$ cup cocoa, $\frac{1}{2}$ cup flour, salt, and baking powder. Spread batter into prepared pan.

Bake in preheated oven for 25 to 30 minutes. Do not overcook.

To Make Frosting: Combine 3 tablespoons butter, 3 tablespoons cocoa, 1 tablespoon honey, 1 teaspoon vanilla, and 1 cup confectioners' sugar. Frost brownies while they are still warm. Enjoy!



Consider this . . .

Fractions may be difficult for learners simply because their symbolic representation is more complicated than those of whole numbers.

As Amanda's class is linguistic and culturally diverse, Amanda understands the power of academic content standards in combination with English language development standards as the basis for her unit design. She wants to ensure that her students have the linguistic stepping stones to develop the necessary understanding for academic success. Her state has adopted the Common Core State Standards (2010), so that is the first place she scours to find the fourth grade skills and concepts related to fractions.

CONTENT AND LANGUAGE STANDARDS

Amanda builds the knowledge and skills required in this unit on fractions around the Mathematics Big Ideas from her state (NCTM, 2001) and connects them to those of the Common Core State Standards (CCSS). Figure 3.1 shows what she found for Grade 4 fractions.

Figure 3.1 2010 Common Core State Standards for Mathematics

4.NF.1	Explain why a fraction *a*/*b* is equivalent to a fraction *(nxa)/(nxb)* by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.
4.NF.2	Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as ½. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.
4.NF.3	Understand a fraction *a*/*b* with *a* > *1* as a sum of fractions *1*/*b*. For example, *3/8* = *1/8* + *1/8* + *1/8*.
4.NF.4a	Apply and extend previous understanding of multiplication to multiply a fraction by a whole number. For example, *use a visual fraction model to represent 5/4 as the product of 5 × (1/4).*

Source: Common Core State Standards for Mathematics, 2010, p. 30.

Having selected the content standards, in this case, the CCSS, she then pairs them with Standard 3, the language of mathematics, from Teachers of

English to Speakers of Other Languages' (TESOL's) *English Language Proficiency Standards* (2006). First, Amanda examines the list of example content topics to check for coverage of fractions in Grade Level Cluster 4-5. Although she doesn't find an exact match of topics in the representative strands, Amanda realizes that she could use her topic, "fractions," for the language domain of listening. Figure 3.2 shows the developmental progression she produces across the five levels of language proficiency from the document.

Figure 3.2 TESOL's English Language Proficiency Standard 3: The Language of Mathematics, Listening

English Language Proficiency Level 1	*English Language Proficiency Level 2*	*English Language Proficiency Level 3*	*English Language Proficiency Level 4*	*English Language Proficiency Level 5*
Identify fractions from oral commands with visual support.	Match phrases to fractions from oral statements and visual support.	Find relationships among fractions according to oral descriptions with visual support.	Sort sentences about use of fractions according to oral descriptions and graphic support.	Analyze use of fractions in various contexts from oral descriptions.

Source: Adapted from TESOL, 2006.

As Amanda realizes that the 2006 TESOL English language proficiency standards are an augmentation of World-Class Instructional Design and Assessment's (WIDA's) language standards, she takes a peek at WIDA's website, and from it she downloads the standards as well as supporting materials. Glancing through the pages for Standard 3, the language of mathematics, in both the 2012 amplification and the 2007 editions, she soon discovers that there is a fractions strand for the language domain of writing. What a nice complement, she thinks, to the other listening strand; she quickly jots it down (see Figure 3.3).

Consider this . . .

For additional information on language standards for preK–12 students, you may wish to refer to the websites for Teachers of English to Speakers of Other Languages (TESOL), at www.tesol.org, and World-Class Instructional Design and Assessment (WIDA), www.wida.us.

Figure 3.3 WIDA's English Language Proficiency Standard 3: The Language of Mathematics, Writing

English Language Proficiency Level 1	*English Language Proficiency Level 2*	*English Language Proficiency Level 3*	*English Language Proficiency Level 4*	*English Language Proficiency Level 5*
Explain by labeling fractional parts using diagrams or realia in conjunction with number word/ phrase banks.	Explain what the fractional parts mean using diagrams or realia in conjunction with phrases or short sentences.	Explain step-by-step processes for solving problems involving fractions using diagrams in conjunction with a series of related sentences.	Explain strategies for solving problems involving fractions using diagrams in conjunction with paragraphs.	Explain differences in solving problems involving fractions for different real-world scenarios or situations.

Source: Adapted from WIDA, 2007, p. 34.

When the fourth grade team meets, it discusses how to make (1) a context for language use and (2) closer ties between WIDA's representation of the language of mathematics and the knowledge and skills embedded within the Common Core State Standards. The real-life context of having the students pose as master chefs and create or convert recipes using fractions excites the team.

The team is pleased that the Common Core State Standards for English language arts stress collaboration and emphasize the role of discussion in listening and speaking (see Figure 3.4). As this fourth grade fraction unit

Figure 3.4 CCSS Standard Used for Student Collaboration and Discussion

SL.4.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

- Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- Follow agreed-upon rules for discussions and carry out assigned roles.
- Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
- Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.

Source for SL.4.1: Common Core State Standards for English Language Arts & Literacy in History/ Social Studies, Science, and Technical Subjects, 2010, p. 24.

engages the class in much student–student interaction, the teachers start scouring and highlighting the standards.

Having selected the relevant standards, at this juncture, Amanda delves into the academic language of the two texts she has chosen to help prepare for the unit.

ACADEMIC LANGUAGE THROUGHOUT THE UNIT

Last year, Amanda was thrilled to have participated in a districtwide committee that explored the academic language of the content areas. The school district realized that having teachers use instructional assessment approaches that centered on academic language not only was critical for language arts but also was at the heart of student achievement for mathematics and the other content areas (Egbert & Ernst-Slavit, 2010; Francis, Lesaux, Kieffer, & Rivera, 2006; Snow & Uccelli, 2009).

Originally thinking that academic language was confined to literacy, Amanda learned that it extends across all language domains (that is, listening, speaking, reading, and writing) and represents three linguistic levels: the *discourse, sentence,* and *word/phrase* levels.

- The **discourse level** is often equated with the text type or genre with which the students must navigate to negotiate meaning. For this unit on fractions, for example, students must deal with definitional language and the language that typifies recipes, such as narration.
- Analysis of language at the **sentence level** generally corresponds with forms or grammatical structures. Sentence frames help students create language patterns associated with a particular content area. Understanding the structure of sentences helps students gain comprehension as well as uncover the content-related skills.
- Academic language at the **word/phrase level** focuses on specific vocabulary, such as words with multiple meanings, or expressions, including idioms or metaphors that challenge language learners.

Amanda has come to realize that academic language is everywhere! That is, the academic language of the theme needs to correspond to both the academic language encountered in student standards and the source materials selected for the unit. Examining the range of academic language specific to each content area makes teachers realize the major role that language plays in enabling students to access and then achieve mastery of grade-level content.

Consider this . . .

The language of mathematics is also called a **mathematics register**. In linguistics a register is a variety of a language used for a specific purpose or audience in a particular context.

The Academic Language of Mathematics

While some students struggle to grasp the nuances associated with fractional parts, Amanda has come to understand that the difficulty also resides in (1) the notation of fractions when interpreting speech and (2) the use of technical vocabulary, forms, and the linguistic complexity associated with fraction problems. Students seem to get lost in the language of fractions, even before thinking about their properties. In essence, it's the academic language that challenges many students in fully comprehending the concepts.

Here is a typical story problem Amanda encounters when looking to reinforce the use of fractions in everyday situations. She is amazed by the amount of academic language her students have to process and understand before applying their mathematical knowledge and skills to solve the problem.

> A first grade class took a poll to identify their favorite ice cream. $\frac{1}{4}$ chose chocolate, $\frac{1}{2}$ chose vanilla, and $\frac{1}{2}$ chose strawberry. 2 kids are lactose intolerant and can't eat ice cream. If there are 22 kids in the class, how many kids liked each flavor? (http://www.softschools.com/quizzes/math/fraction_word_problems/quiz696.html)

Consider this . . .

What is the academic language that students face in this problem? What are the words, phrases, and grammatical structures that might hinder understanding for ELLs? What is the sociocultural context implicit in this story problem with which students are expected to be familiar? For more information about the challenges of word problems, see Figure 1.4 in this volume.

Much of the language involved in Amanda's fractions unit is taught explicitly in context. At the beginning of this and every thematic unit, Amanda asks herself the following question: "What language will students need to know to access grade-level material and to demonstrate understanding of the topic and concepts?" With that question in mind, Amanda reviews a variety of the printed materials students will use, including the textbook, workbook, homework, and, for this unit, recipes. The result

Figure 3.5 Range of Academic Language Encountered in Text Materials on Fractions

Text Type	*Discourse Level*	*Sentence Level*	*Word/Expression Level*	
Grade-Level Mathematics Text	Definitions (related to fractions)	The ___ is called the _____. The whole might be the entire _____.	• fraction bar • whole number • parts of wholes	• except • two thirds • two out of three
Brownies Recipe	Directions (for following the recipe)	Imperative verbs (e.g., *preheat, combine, mix*) Sequential language (e.g., *first, second, then, next, later, finally*)	• recipe • ingredients • measuring cup • frosting • utensils • one-half cup • one-quarter tablespoon	• convert • double • triple • halve • divide into • teaspoon

of this review is the linguistic inventory depicted in Figure 3.5. Examples are categorized according to the quantity and organization of language from the greatest amount, discourse, to the smallest chunk of language at the word level.

The analysis of the academic language of text related to the theme, along with the selected grade-level standards, provides the fourth grade teachers with the necessary information for creating targets for the unit.

Content and Language Targets for the Unit

During their joint planning time, Amanda and the fourth grade team decide on content and language foci for instruction and assessment of each thematic unit for all the fourth grade students in the school. The content target exemplifies the most critical knowledge and skills of the unit, while the language target centers on the necessary language for accessing and achieving those concepts and skills. At times, the language and content targets tend to overlap, as often they share the same academic vocabulary.

Keeping in mind the academic language tied to the concepts of fractions, the team decides on the targets to use throughout the unit:

Content Target for Students:	Students will solve and explain mathematical problems involving fractional parts.
Language Target for Students:	Students will describe and compare the use of fractions in a variety of situations.

Amanda realizes that by crafting a single content target and a single language target for the unit, teachers have a central focus for instruction and assessment over a several week period. The targets provide the big picture for the unit, and Amanda constantly refers to them in evaluating student learning. The language and content objectives for individual lessons come later; they break down the targets into more manageable, daily segments.

Linguistic and Cultural Resources

The fourth grade team realizes that the students themselves are linguistic and cultural resources that enrich instruction and bring a sociocultural grounding to each classroom (Moll, Amanti, Neff, & Gonzales, 1992). The teachers also understand that the use of cultural referents in teaching creates bridges to the mainstream, while recognizing and affirming the students' cultural roots, and, at the same time, exposing all students to multicultural perspectives. Building on Yoshio's paper folding tradition in his Japanese culture, Amanda gives Yoshio an opportunity to shine as he leads the class in making origami paper cranes as a way of describing the use of fractions.

Since Amanda has several students who are literate in Spanish, she looks for ways to differentiate instruction. She realizes that there are English–Spanish cognates for her fractions unit at one of her favorite websites. She prints English–Spanish cognates in large font on a 14 × 11 sheet of paper and posts it on the corner of her bulletin board. As Selena and Carmen are Spanish-speaking buddies, Amanda makes sure that Carmen reads the cognates orally and discusses them with her partner, who struggles with literacy. Although Amanda speaks very little Spanish, she hopes this language support assists all her Spanish-speaking students throughout the unit. Figure 3.6 lists cognates in English and Spanish that may be useful for the fractions unit.

Consider this . . .

Cognates are words in one language that are similar in both meaning and form to words in another language (e.g., *park* in English and *el parque* in Spanish). What might be some cognates for this unit in other languages?

Figure 3.6 Potential Use of Spanish Cognates in the Fractions Unit for Spanish-Speaking Students

Fractions—Fracciones	
English	*Spanish*
convert	convertir
denominator	denominador
double	doble
equivalent	equivalente
fraction	fracción
mixed	mixto
multiple	múltiple
numerator	numerador
package	paquete
quadruple	cuadruple
rational	racional
triple	triple

Encouraging the School–Home Connection

Amanda is keenly aware of the importance of bringing the students' home life into school and that exchanging family recipes would encourage the home–school connection. In the process, students would also learn about each other and about different cooking ingredients, while family members would enjoy volunteering in the classroom.

Thinking of other ways to value the students' home cultures for this unit, Amanda plans to have students design a multicultural recipe book to showcase, perhaps even to sell at the school fair. When students' languages, cultures, and experiences become ingrained in the classroom climate, Amanda notices an increase in the students' attention and levels of involvement. The use of instructional assessment supports also promotes the students' sustained engagement in activities.

INSTRUCTIONAL SUPPORTS

When planning instructionally embedded assessment for ELLs, Amanda always keeps different supports in mind. Supports provide a mechanism

for scaffolding learning as students develop their language skills (Gottlieb, Katz, & Ernst-Slavit, 2009). There are a variety of instructional supports, including the following:

- sensory (e.g., gestures)
- visual (e.g., pictures, films, videos)
- verbal (e.g., choral responses)
- interactive between and among students (e.g., in pairs or small groups) or with technology
- tactile, as in touching or working with real-life objects (e.g., clocks, money) and manipulatives (e.g., geoboards, Unifix cubes, measuring cups)
- graphic (e.g., Venn diagrams, T-charts, matrices, time lines)

Below is a description of the instructional supports Amanda used during this fractions unit.

Using Realia to Concretize Concepts

Realia are objects from real life used in classroom instruction to improve students' understanding of concepts or to connect learners with the key focal point of the lesson. Since the use of realia involves students' use of their senses, it is particularly helpful for second language learners. In this unit, Amanda uses oranges and brownies to display tangible fractions with the class.

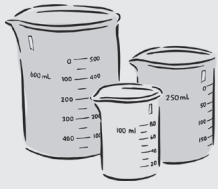
Mathematics is in every kitchen as well as on every recipe card and in every cookbook. Following (and enjoying) recipes allows students to find real-life applications for fractions. Using recipes is an excellent way to practice converting sizes and amounts, using different ways of representing temperatures (Fahrenheit and Celsius), following step-by-step instructions, and multiplying and dividing fractions. Students' use of kitchen tools helps them visualize measurement conversions.

Displaying Mathematics Word/Phrase Walls

Knowledge of the math register is an essential component of learning mathematics. In order to communicate math thinking and understanding, students need to learn and use appropriate math vocabulary and phrases. Math word/phrase walls provide scaffolds to bridge general math language, such as *goes into* and *take away,* with the technical terminology of mathematics, as in *division* and *subtraction.* Students in Amanda's classroom use the word wall often. Words and phrases are added as they are introduced in the day's lesson, and students can borrow words as needed.

While Amanda's math word wall can be considered student-centered and organic because it is constantly used and growing, she also has a set of permanent posters reminding students of the different terms and expressions that refer to mathematics operations.

Our Fraction Wall

Least common denominator	Three out of four	Numerator	
Fractional part	Equivalent	One-half cup	
Like fractions	Fair share	Mixed number	Ingredients
Parts of whole	Equal amount	Double the recipe	
Divide in (halves, thirds)	Is greater (lesser) than	Utensils	

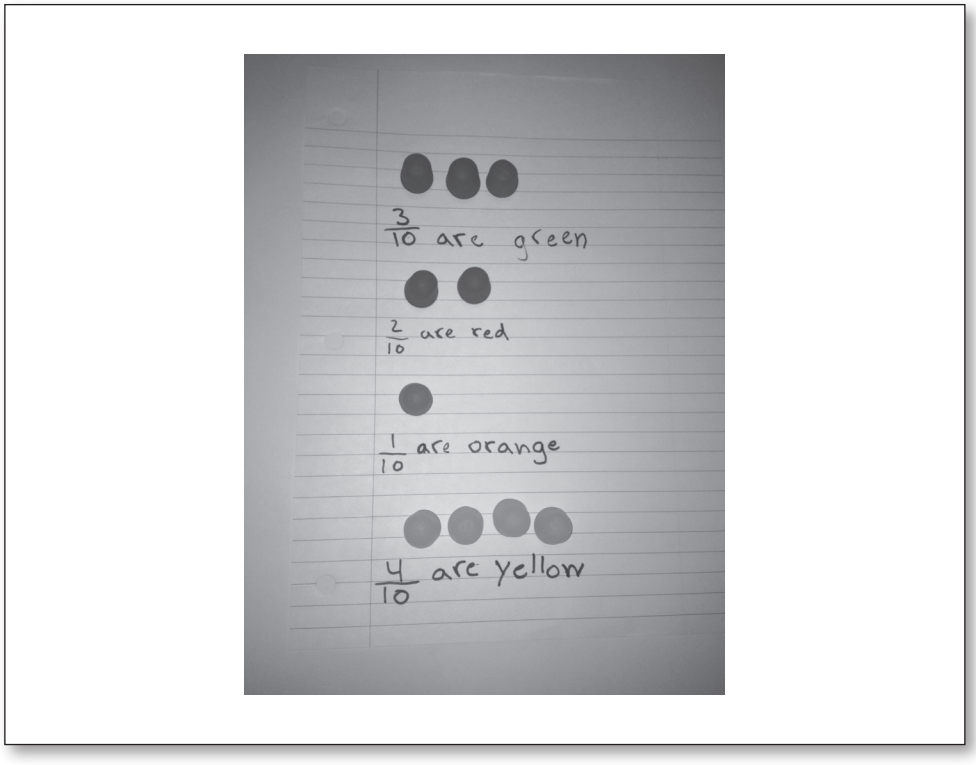
Constructing Fractions With Manipulatives

Manipulatives are concrete objects that students can move around to support their thinking and learning. The National Council of Teachers of Mathematics emphasizes the importance of using manipulatives and visual representations, as well as mathematical modeling, in all grade levels. Smarties, M&Ms, or colored counters, for example, provide a concrete and fun way of representing, thinking about, and manipulating fractional amounts (see Figure 3.7).

Locating Fractions on a Number Line

The use of number lines helps children understand that fractions are numbers. To help students identify where fractions "live," a number line offers opportunities to visualize fractions and integers as the same kind of mathematical object.

Figure 3.7 Using Candy to Represent Fractions



Encouraging Student Interaction

Besides these instructional aids, Amanda also strongly believes that students need ample opportunities to use, repeat, and practice the language of mathematics with each other—in pairs as well as small and large groups. As part of her daily routine, she makes sure that the students have enough time time to discuss the unit's concepts, reinforce the lesson's objectives, and try out their new language. As she honors the use of the students' home language, Amanda encourages Sasha and Vadir, in particular, to paraphrase some of the ideas presented, since Russian is their stronger language.

Small Groups

During small group instruction, students work cooperatively to discuss the topic at hand, share information, explore and problem solve, or accomplish

a common goal. This type of arrangement, coupled with well-designed content and language targets, provides opportunities for divergent thinking and encourages students to practice the specific content-area language.

Think-Pair-Share

This interactive cooperative strategy affords students time to formulate individual ideas and share these with another student. It encourages and honors student thinking about the concepts and ideas being discussed. It also promotes language use between peers and classroom participation by all students.

Do-Talk-Record

In this teaching strategy, learners engage in activities and thoroughly discuss them before recording any results. In this way, students have opportunities to practice the language of mathematics before they produce their answers. Initially, teachers may need to model the talking and then have a round of guided practice before students grasp the process and are able to work independently.

Having thought through the various instructional supports and scaffolds for student learning, Amanda finds that formulating language objectives to guide her daily language instruction is easy.

DIFFERENTIATED OBJECTIVES

The school as a whole has been studying differentiated instruction of content and uses a coaching model for reflecting on different instructional strategies. Over time, teachers have provided students with various pathways to acquiring the knowledge and skills of grade-level content so that everyone within a classroom is a participant in learning, regardless of any differences in ability. But now, with such a strong influx of ELLs, Amanda and her team must think about the importance of differentiating language instruction as well.

Differentiated Content Objectives

As a prerequisite for writing content objectives for the unit's lessons, Amanda and her fourth grade team spend some time analyzing the Common Core Standards for Mathematics that they have selected.

They realize that deconstructing the standards into what the students should know (the concepts) and be able to do (the skills) will help guide their thinking about expected student performance. Once they have identified the specific content for the two broad groups of students, formulating the content objectives is easy. So, as highlighted in Figure 3.8, together they plan for instruction.

Figure 3.8 Deconstructing Mathematics Content Standards Into Their Concepts and Skills to Create Differentiated Content Objectives for Student Groups

Concepts Embedded in the Fourth Grade Common Core State Standards for Mathematics	*Related Content Skills*
• Fractions • Equivalent fractions • Common denominator/common numerator	• Represent fractions • Order fractions • Multiply fractions • Determine equivalency of fractional value • Compare like and unlike denominators and numerators • Convert mixed numbers to proper/ improper fractions
Content Objectives for Students With Conceptual Understanding of the Standards • Represent fractions with creative examples. • Do mental math when multiplying fractions. • Determine equivalency of fractions using sports or other analogies.	
Content Objectives for Students Challenged by the Concepts and Skills Represented in the Standards: • Represent fractions relying on physical models. • Construct multiple fractions using realia or manipulatives. • Determine equivalency of fractions referencing the baking analogy.	

Having scribbled down the content objectives, the teachers next grapple with the language associated with the knowledge and skills to make language objectives. When thinking about differentiation of language, Amanda's main concern is how to maximize her students' access to grade-level content.

Differentiated Language Objectives

Given the tremendous language demands of this unit, Amanda sets out to establish clear achievable language objectives for all her students. Keeping the unit's language target in mind, she readily breaks it down lesson by lesson into language objectives that fit her ELLs' levels of language

proficiency. In addition, designing instruction around explicit language objectives helps Amanda focus on scaffolding language for individual students from day to day.

With the theme of fractions and her selected English language development standards, the unit's materials, and the language target, Amanda drafts the language objectives for her students. With such a heterogeneous group of language learners across the entire spectrum of English language development, Amanda decides it best to differentiate instruction according to three groups of students:

1. Students proficient in English, including the students she is currently monitoring (Diep, Luis, and Marisol) and others who are being considered for learning disabilities
2. Intermediate-level ELLs who have reached the half-way point or more in their English language development
3. Beginners who are just becoming acquainted with English

Figure 3.9 shows the language objectives, differentiated by language proficiency groups, for the language domains—listening and speaking (oral language) as well as reading and writing (literacy). Note how the language objectives, synchronized with the overall language target, provide realistic expectations for each group of language learners.

Figure 3.9 Differentiated Language Objectives for the Fraction Unit

Oral Language and Literacy Objectives	
All students, with particular attention to recently exited ELLs	• Use technical vocabulary, expressions, and sentences to describe fractions. • Use comparative language to contrast fractions. • Use sequential language in stating procedures to prepare a cooking recipe.
Intermediate ELLs (ELP Levels 3–4)	• Use descriptive words, phrases, and modeled sentences to describe fractions. • Use comparative terms such as, " ____is more than____," "____is less than____," "____is equal to____" to identify fractions. • Use sequence terms (such as *first*, *second*, *third*, *next*, *later, finally*) to describe steps of cooking recipes using a graphic organizer.
Beginning ELLs (ELP Levels 1–2)	• Reproduce words and phrases to describe fractions from math word wall. • Distinguish between *bigger than* and *smaller than* to compare visually supported fractions. • Show basic steps of cooking recipes involving fractions using visuals.

Using her differentiated language and content objectives that are based on the unit's targets and standards, Amanda now prepares the instructional activities.

INSTRUCTIONAL ACTIVITIES

One way Amanda makes this unit on fractions more meaningful for her students is to have it relevant to their lives. That is why she begins and ends the unit with real objects—oranges and brownies! Over the years, Amanda has learned that many students find fractions difficult to understand, even though children use fractions in their daily lives. Both the conceptual and language loads prove challenging for the students. Figure 3.10 shows a breakdown of the academic language across linguistic levels for the planned activities.

Figure 3.10 Academic Language Embedded in the Unit's Activities

Activity	*Discourse Level*	*Sentence Level*	*Word/Expression Level*	
Introductory orange activity Understanding the way fractions are used		$\frac{3}{5}$ means 3 out of 5 $\frac{2}{3}$ is 2 parts of 3	• one whole • one half • one third • one fourth • two halves • two thirds • two fourths • twice as much • fraction of _____($\frac{1}{3}$ of 6)	• fraction • fraction bar • numerator • denominator • equal • mixed numbers • like fractions • part • whole
Using Smarties on the number line	Explanation	The amount in the package is_____. The amount of ____ (color) in the package is ____.	representations rational numbers whole numbers	
Fractions in Measurements	Narration/ Word problems	There are X ___ in all. X of the ___are___. X out of Y are ____.	probability scale ratios	

Activity	*Discourse Level*	*Sentence Level*	*Word/Expression Level*	
Mixed Numbers	Definition	Number and fraction (e.g., "three and two thirds" means. . . .) Another way of saying _____is _____.	• mixed number • proper fraction • improper fraction • equivalent fractions • simplest form • lowest terms • decomposition	• common denominator • percent • doubling the amount • tripling the recipe • quadrupling
Comparing Fractions	Comparison	<, >, = _____is more than_____. _____ is less than_____. _____is equal to_____. One half is bigger than one third because_____.	like and unlike denominators and numerators	

For this particular unit, Amanda and her team create a series of related activities that reinforce each other rather than design activities that fold into more complex tasks or a project. Woven into the hands-on, performance activities during instruction are in-class assessments, or quick checks, that allow Amanda to gauge the students' understanding of language or content and to clarify any misconceptions (Fisher & Frey, 2007). Thus, Amanda is busy collecting evidence from her students within her instructional routine, and these ongoing data inform and improve teaching and learning in her classroom.

In introducing fractions, Amanda realizes that she wants to build from her students' interests; thus, she decides to base her preview on Jonathan's excitement over the fool's gold. She launches into the following scenario:

Amanda: Let's say that these 4 friends (pointing to a group on her left) are on a long hike searching for pyrites and fossils (shows two rocks). After many hours of walking, they are starving. But they have only these oranges to eat (she distributes 3 oranges and a plastic knife to each group of four students). How do they divide 3 oranges so that everyone gets a fair share? That

Consider this . . .

Notice how Amanda quickly realizes that her students are not familiar with the expression *fair share*, so she defines it within the continuing flow of discourse.

Consider this . . .

Why does Amanda ask her students to use complete sentences? Does this serve mathematical as well as linguistic purposes?

means that each friend gets an equal amount. Figure out with your team how you would divide the oranges so that everyone has an equal amount. How do you cut the 3 oranges so each of the 4 friends gets their fair share?

The students are genuinely interested in solving this problem. The classroom buzz eventually funnels into some creative suggestions as to how to cut up the oranges.

Amanda: So how did you solve this problem? Please use complete sentences.

Oksana: We knew we had to cut each one into fourths, since there were 4 friends. We did that. Then we started giving them out, and each person got 3 pieces of the orange.

Chad: That's what we did. That's what we did.

Amanda: Tell me another way.

Chad: We did the same. We had 12 pieces and we divided them into 4. That was 3.

Amanda: You are both correct. Each person got $\frac{3}{4}$ of an orange.

After a bit more sharing and clarifying, Amanda lets the students munch on their pieces of orange. She then probes Oksana and the rest of the class on what specifically is meant by "three fourths."

Oksana: It means 3 out of the 4. $\frac{3}{4}$. If you have 4, you get 3.

Selena: I think $\frac{3}{4}$ is almost 1.

Amanda: Vadir (whose hand was raised), let's hear from you.

Consider this . . .

What are the advantages and disadvantages of paraphrasing students' words?

Vadir: Well, 3 4s, not 4 4s. It's 3. 1 more makes 1. Almost 1.

Amanda realizes that Vadir's wording was rather difficult to follow, so she paraphrases Vadir's comments.

Amanda: So you're saying that we need one more fourth (holding up a piece of orange and emphasizing the *th* in *fourth*) to go with these three fourths (holding up 3 pieces of oranges so that they take the shape of a ball missing a chunk) in order to get 1 whole orange. $\frac{1}{4}$ plus $\frac{3}{4}$ is 1. 4 (holding up 4 fingers) fourths (holding up a piece of the orange) is the same as 1 (holding up all 4 pieces, arranged in a ball).

Vadir: Yes.

Amanda: Class, thumbs up if you agree with Vadir; thumbs down if you disagree with him.

Consider this . . .

How is the thumbs up, thumbs down strategy an effective one for a quick in-class check for understanding?

Amanda scans the room and sees a sea of thumbs up with many looks of comprehension. This first activity appears to be a success. The students seem to understand the idea of *fourths,* and a subsequent discussion introduces the terms *numerator and denominator.*

Amanda asks students to put these terms and notations on the math word/phrase wall on the side of the room, which is beginning to grow. At the end of the class, as another within-lesson assessment, Amanda asks everyone to draw a picture of $\frac{3}{4}$, label the fractional parts, and explain in words why the picture is an example of $\frac{3}{4}$. The students use their pictures and explanations as exit slips that day; as they say their good-byes, the students hand Amanda the drawing of their fraction and describe it to her.

Midway through the unit, the students are becoming more comfortable with both fraction ideas and the associated math language. However, Amanda's in-class content assessments indicate that many students still tend to struggle with the concept of part-whole, the content skills of adding and subtracting fractions, and how to verbalize their understandings.

Despite this, Amanda is excited by today's class, as she plans to use real-life objects to help students get a better grasp of the abstract concepts. Giving out packets of Smarties, she has students construct fractional amounts and mixed numbers using whole and partial packets. Each packet of Smarties has 15 candies and represents the unit whole; "loose" Smarties represent fractional pieces. Because there are 15 pieces in a whole, the fractions have denominators of 1, 3, 5, and 15.

Amanda's content objective for the lesson is to have students translate their fractional ideas to the number line. Giang is given a whole packet and

three extra pieces of Smarties, which he lays out on the document camera, and is asked to discuss his ideas. Unfortunately, the students grow increasingly confused.

Ben: I don't get what Sasha said. How could it be $1\frac{1}{5}$ when there are 3 extra pieces?

Giang: The 3 are $\frac{1}{5}$. It is $\frac{1}{5}$. There are 15 total, so it is $\frac{1}{5}$.

Emilio: How does 3 be $\frac{1}{5}$? It's 3.

Giang: It's 3 of all bag of Smarties. 3 of the total. 15. 3 out of 15.

Jana: But there is only 1 whole Smarties there!

Consider this . . .

Why do you think Amanda feels the conversation is degenerating? In what way? What might you do to counteract this misunderstanding?

Amanda feels that the conversation is degenerating. She knows what Giang is trying to explain, and has a good idea of how Ben, Emilio, and Jana don't comprehend his meaning. Amanda decides to paraphrase again.

Amanda: So let me see if I get it. You have 1 whole packet (holding up the complete packet of Smarties). Then you have 3 more pieces. But because there are 15 Smarties pieces in a packet, that is $\frac{3}{15}$, or $\frac{1}{5}$ more of a packet.

Giang nods vigorously, but many others in the class seem quite bewildered, maybe as much from the words as from the fraction ideas. And time is running out. Amanda quickly decides to use the final 10 minutes of class on a content-based assessment in which she asks the students to represent $\frac{1}{5}$ and $\frac{3}{15}$ and make any connections they could between the two fractions. Observing the students in action with their Smarties, she realizes she needs to continue the lesson tomorrow.

Consider this . . .

Why do you think Amanda goes beyond correct percentages in her analysis of student work? What do you think she did to determine that limitations in student thinking related to "parts of a whole being shaded?" How might she use this information?

That night, Amanda thinks of an idea to reinforce the lesson's concepts. Amanda gleaned from yesterday's walk around that more than half of her students could represent fraction amounts by placing Smarties on the number line, but about a third failed to indicate that two fractions were equivalent. Most of the student thinking related to "parts of

a whole being shaded." She remembered Yoshio's connections to the Japanese tradition of origami, the traditional Japanese art of paper folding. A few weeks ago, Yoshio taught the class how to make origami cranes.

The next day, Amanda gives each student several long rectangular strips of paper that are each 11 inches × 1 inch. She then asks Yoshio to model how to fold a strip into halves, thirds, and fourths—each time asking how much one section of the folded paper would represent. She then forms groups of four or five students and asks each group to prepare a fraction wall chart by folding their paper so that a section would represent the following fractions: $\frac{1}{1}, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{6}, \frac{1}{8}, \frac{1}{9}$, and $\frac{1}{12}$ (see Figure 3.11). She wants them to trace the lines of each fold and to talk to each other about how they know they are correct. She models this activity by saying, "I know each piece is $\frac{1}{3}$ because I folded this paper into 3 equal pieces, and 1 of 3 equal pieces is exactly $\frac{1}{3}$." She then writes "$\frac{1}{3}$" on the first folded section of the paper strip.

Figure 3.11 Luis Making His Fraction Wall Chart

Consider this . . .

How might observation, coupled with a checklist, help monitor the progress of students' skill attainment throughout the unit?

The room is buzzing, students are smiling, and, after creating all of their strips, they identify several different pairs of equivalent fractions. Amanda hears several comments that also reflect student understanding of part-whole relationships, and several uses of academic language, such as *numerator, denominator, equivalent, part and whole,* and *simplified.* She quickly goes to her list of content skills for the unit and checks off those students who demonstrate understanding of equivalent fractions and the terms, along with today's date.

Amanda then leads the students in think-pair-share discussions driven by the following three questions displayed on the document camera:

> How many equivalent fractions can you find?
>
> What is the relationship between the size of an individual piece and the number of sections in the paper?
>
> Which is bigger: 3 out of 4, or 8 out of 9? 3 out of 8, or 5 out of 12? Can you think of other interesting comparisons?

As Amanda circles the room, she is quite pleased with the fractional thinking her students are displaying; she is quick to give the students focused, descriptive feedback on their work. She ends the class with a check on equivalent fractions, on which most students perform very well. This momentum is carried through the next several lessons, which include discussions of decimals, comparing fractions, and probability. Amanda is excited, having arrived at the end of the unit and feeling that her students are prepared for her culminating activity—altering recipes.

Consider this . . .

The term *like fractions* can be confusing for students, especially ELLs, since *like* has several meanings. For example, like can be a verb (I *like* bread), an adjective (he followed with a *like* response), a noun (it's been *like* such a long time), or a conjunction (you don't change your values *like* you change your hat). In this case, the different fractions with the same denominator are *like fractions.* A brief review of the different meanings might be helpful for all students.

With the cooking lesson about to begin, Amanda enters the room smiling. "Who's hungry?" she asks. All eyes are on her, but some students also can't keep their eyes off the blanket that mysteriously covers the table in front of the room. Amanda questions

the silent room, "No one?" Instantly, all of the students shout, "Me!" When Amanda asks, "Who likes chocolate?" the room's noise level quickly rises.

Amanda: Listen up. That means that you have to do something so you can eat chocolate bars called brownies. Just like some of you do at home, you need to help me with the recipe. I can't do this alone.

Riley: What do we need to do?

Amanda: Well, how many people do we have in this classroom?

Selena: 23.

Emily: Don't forget about Ms. Thorne. That makes 24.

Amanda: Thanks, Emily. I think I'd like some, too. But there's a problem. Look at my recipe and tell me what you think we need to do.

At this point, Amanda displays the Scrumptious Brownies recipe (see p. 85) using her document camera. Several students comment on the amount of information ("too much stuff!"), while others seem surprised by all of the written text in math class.

Consider this . . .

Should this amount of text be used for fourth graders? Should Amanda have reduced the amount of text for the recipe or represented it in a different way?

The students are quite anxious to talk about their ideas, and many comments slip into discussions of their families' favorite recipes. Some students discuss the particular ingredients, or the purpose of a recipe. Amanda acknowledges how each culture has unique recipes reflective of the foods of a particular region or country and encourages the students to bring in family recipes.

One way to learn a register, such as the mathematics register, is to connect terms to meaningful representations. Amanda has spent a good deal of time doing this, but she realizes that, for this series of lessons, a new register would need to be developed. She has to teach some baking language in order for the students to comprehend and think about the information in the recipe.

Amanda brings in measuring tools (cups, spoons) and all the ingredients, which she keeps hidden in a mysterious paper bag, to help her lead a discussion to develop these terms. She also had enlisted two parents as helpers.

Amanda continues the discussion by having students take out the ingredients and measuring tools from a grocery bag, naming them one by one, and laying them on her table. She points to the final line in the recipe, and asks the students to read it together. She then returns to her original question.

Amanda: OK, we have 24 people in the room. Does this recipe work for 24 people?

All: No!

Amanda: How many does it work for?

All: 16!

Amanda: Yes, the recipe says "serves 16." That means it makes 16 portions. But that would mean only 16 people could have a brownie. [Amanda makes a sad face.] So what should we do? Please answer in a complete sentence.

Ophelia: Make it bigger.

Amanda: Can you say that in a sentence?

Ophelia: We can make the recipe bigger.

Cecilia: Double it!

Amanda: Tell us again, using a sentence.

Cecilia: OK. We can double the whole thing.

Amanda: What thing?

Cecilia: We can double the whole recipe.

Emilio: Yeah, double or triple it.

Amanda: Yes, we can double the whole recipe. Why would we do that?

Consider this . . .

How do gestures help reinforce the classroom discourse and further students' oral comprehension?

Several students make comments such as "so everyone can have some" and "so there's enough for everyone." Amanda wants to shift to a more mathematical analysis, and also to develop the language necessary to do so.

Amanda: Hmm. Let's see. Good ideas. But let's think about this recipe a bit more. Who knows what the first line means? (She points to "$\frac{1}{2}$ cup butter.")

Arthur: $\frac{1}{2}$ cup butter.

Amanda: OK, but what is "$\frac{1}{2}$ cup butter?" (She holds up the butter packet and the cup.)

Max: You need to fill up the cup with butter until it's halfway.

Amanda: So I fill it up?

Max: No. Just halfway. You only need half a cup.

Amanda: Oh, OK. This is a whole cup, and I only need half a cup. So I need to put butter in until it is halfway full. Hey, look!! Right here on the label (she points to the stick of butter). It tells me how much $\frac{1}{2}$ cup is!

Amanda places the wrapped butter stick on the document camera and points out the measurements written along one side. She emphasizes the expression "stick of butter," as not all students are familiar with the terminology or may think about "stick" in other ways.

Amanda: Does this look like ½ cup?

All: Yes.

Amanda: Why?

Greta: Because it fills the cup halfway.

Sam: Because it goes halfway up.

Amanda: OK, but can you tell me how you know it fills the cup halfway?

Sam: Just look at it. It's halfway up. Well, it might not be exact, but it's about half full.

Amanda: Well, what do we mean by *one half?*

Consider this . . .

Why does Amanda have a discussion about the term *one half* at this point?

Amanda intends to bring the students' prior fractional understandings to the forefront of this cooking conversation. Her last question raises some of her students' eyebrows and sends some wheels turning. After a short moment of silence, one student responds.

Elisha: It means it's got equal parts.

Amanda: What has equal parts?

Elisha: The cup. Half has butter, and half is empty.

Amanda: Hmm. OK. So what does $\frac{1}{2}$ mean?

Emilio: It means 1 of 2 things. 1 of 2 pieces.

Amanda: Good. 1 of 2 equal (emphasizing *equal*) pieces. And is that what we have here?

Emilio: Yeah. You've got 2 pieces. You've got the half with butter and the half without butter. And since you've got half with butter, that's the 1 of the pieces that you got. So you've got 1 out of the 2 pieces.

Amanda does not respond. After a few seconds she asks, "Any questions for Emilio?" After being asked, "What do you mean?" Emilio continues:

Emilio: Well, it's not really pieces. It's halves. It's 2 halves of a cup. 1 piece is half, and the other piece the other half. 1 half is butter, so that's the 1 half you have. And then you have the other half.

Amanda: Great, Emilio. You are talking about having 1 (she points to the bottom of the cup) of 2 (simultaneously points to the top and bottom of the cup) pieces. Can other students tell me in their own words what half means? Oksana?

Oksana: Yeah. It means 1 out of 2. If you have something, you split it into equal pieces, and you get 1 of them. That's half.

Amanda: Super. How do we know we have equal pieces?

Oksana: It looks like it.

Giang: The paper said so.

Amanda: OK. I guess we'll trust the paper, the wrapper, because it does look like $\frac{1}{2}$ to me. So we have 2 equal pieces (points to the top and bottom of the cup), and 1 of them (points to the bottom of the cup) has butter in it. So we have $\frac{1}{2}$ cup of butter. I'm going to hand out a slip of paper for the word wall. I want each of you to choose something important we've said about "$\frac{1}{2}$ cup" and write about it. (She busily writes down "$\frac{1}{2}$ cup" on the paper and shows the class.)

Consider this . . .

What kind of information will Amanda obtain about her students' content knowledge and academic language using this within-lesson assessment?

With this assessment embedded within instruction, Amanda is pretty sure that her students have understood

the terms *a stick of butter* and *cup* and how one half relates to this situation. After quickly going through the next three ingredients, she asks about "$\frac{1}{3}$ cup unsweetened cocoa powder." After a short discussion of what *unsweetened* means, the students arrive at the notion of one of three equal parts quite readily. Amanda reinforces this by pointing out the "$\frac{1}{3}$" markings on her cup, and pours the cocoa powder up to that line. The class then reads the rest of the ingredients aloud, and Amanda finishes with a brief review of each ingredient and amount.

Amanda You are doing great. Now, who remembers what we want to do?

Sasha: Brownies!

Amanda: Yes, Sasha, we are making brownies. Are we ready to make brownies?

All: Yes!!

Amanda: Do we know how many brownies we need to make?

All: 24

Amanda: Mm hmm.

Bob: Oh, yeah. The recipe said it makes 16. We need to double the recipe.

Jill: No. We don't have 32 people. We only have 24.

Bob: So. We can make more.

Amanda: Jill, why did you mention 32 people?

Jill: Because 32 is double 16.

Amanda: OK. 32 is double 16. It is twice, or 2 times, 16. So when we double something, we multiply it by 2. Is that right? Maybe we should add that to the word wall, too.

Because time is running out, Amanda gets the class to clarify the meaning of the term "double the recipe" as doubling each ingredient. After asking the students to talk with their elbow partner about what would happen if the recipe is doubled, she then asks the class to restate their ideas in groups. She gives a copy of the recipe to each group and asks them to

Consider this . . .

Why does Amanda choose to have paired discussions before the group work activity? What is she hoping to accomplish? Would additional time devoted to the large group activity be more beneficial?

write "Double the Recipe" on the top, and then replaces the ingredient amounts and servings with their new amounts. Amanda is amazed when she analyzes the content skills evident on the students' recipe cards that evening.

The next day, Amanda insists that the students make exactly the amount needed. Using visuals and ideas from past lessons, she leads a discussion to determine the need to multiply 16 by $1\frac{1}{2}$ to obtain 24, and how $1\frac{1}{2}$ was the same as $\frac{3}{2}$. She again passes out the recipe and asks the students to write "Increase the Recipe by $1\frac{1}{2}$" on the top, and to replace the original amounts by the adjusted ones. After the students share and exchange their new amounts, Amanda displays five plastic trays with measuring tools and ingredients on each.

Her announcement of "Let's make brownies!" is greeted by cheers and squeals. The room is abuzz as the students measure and mix the ingredients, starting with the melted butter that Amanda prepared before class. Amanda circles the room checking measurements and asking questions of individual students. The two parent volunteers are quite helpful in keeping things in order and in clarifying the instructions for Sasha and Vadir, the two newcomers, in Russian.

Amanda also displays one of the student posters from last year as a model that clearly explains and illustrates the recipe's steps, to which some of the students refer frequently. At the end of class, she promises to bring back each group's brownies the next day, in exchange for a favorite recipe from home. The following day is spent munching on brownies and altering the students' home recipes by a factor of 2, $1\frac{1}{2}$, and $\frac{3}{4}$. This activity is followed with students describing in their small groups the process of altering recipes. Amanda reminds the students to use their sequence words (e.g., *first, next, later, finally*) as they relate their family's recipes.

As a culminating activity, the team decides that each fourth grader will create an illustrated poster. On the final day of the unit, all the students bring posters showing and labeling all the ingredients and steps of their selected recipes from home. In each class, the students proudly make presentations using their posters as a referent, while the other students and the teachers complete a rating scale.

ASSESSMENT WITHIN AND ACROSS THE UNIT

Amanda uses multiple forms of assessment to get a comprehensive profile of student performance. Throughout the unit, Amanda collected different kinds of data about her students' progress. In addition, she and her fourth grade team collected summative assessment data during the culminating activity of the unit.

Amanda, as all teachers, has her individual teaching style, means of managing her classroom, and special relationship with her students. Her daily assessment practices are intertwined with instruction and are unique or idiosyncratic to Amanda's classroom. Thus, day-to-day progress monitoring, based on content and language objectives, is planned, but the resulting data are retained within the classroom walls (Gottlieb & Nguyen, 2007).

Consider this . . .

Often the terms *formative* and *summative* assessment are used to describe the collection and analysis of data for lessons and units, respectively. They are not used in this chapter, as we believe that these terms refer to how the data are used rather than to types of measures. Do you agree or disagree with this use of the terms?

Assessment that covers the unit of study, on the other hand, based on content and language targets and corresponding standards, is a fourth grade team decision. This common assessment is comprehensive in scope and contributes to local, school-based accountability (Gottlieb, 2012).

Assessment Within the Unit's Lessons

Amanda uses a variety of assessments, tools, and techniques to chart the students' progress in understanding mathematical concepts and skills along with their understanding of the language of mathematics throughout the unit. She realizes that just as language instruction is differentiated for ELLs according to their levels of language proficiency, so too, should differentiation be mirrored in assessment (Fairbairn & Jones-Vo, 2010; Gottlieb, 2006). Equally important are the supports for students during instruction that should extend into assessment.

Within each lesson, Amanda is careful to tell the students to concentrate on what they say or write (the language side) or to show their math skills

Figure 3.12 Instructional Assessment Used to Measure Knowledge (Concepts) and Skills Related to Fractions in the Unit

Mathematical Content	*Assessment of Mathematical Content*
Knowledge (Concepts) • Representation of fractions • Equivalency of fractions	Having students • Place fractions on the number line • Use manipulatives or real objects
Skills • Addition and subtraction of fractions • Multiplication of fractions by whole numbers	 • Solve raw mathematics problems • Double or halve fractions

(the content side), and she provides individual or small group feedback based on student performance in relation to the criteria. Figure 3.12 relates the types of assessment used to measure mathematics concepts and skills.

The fourth grade teachers, like other teams in the school, specifically look for accuracy and precision in measuring the content target—in this case, the students' calculations in solving mathematics problems. However, when it comes to determining whether her ELLs are acquiring the academic language of mathematics, as shown in Figure 3.13, Amanda uses observation and students' writing to determine how the students are communicating mathematically.

Figure 3.13 Instructional Assessment Used to Measure Oral Language and Literacy Throughout the Unit

Academic Language	*Assessment of Academic Language*
Oral Language (Listening and Speaking) • Explaining your work • Describing fractions • Following a recipe	Having students • Show thumbs up, thumbs down • Ask and answer exit questions • Make oral presentations
Literacy (Reading and Writing) • Drawing, labeling, and describing fractions • Following written directions	• Make journal entries • Post to the word/phrase wall • Create recipe cards • Draw/write exit slips

Amanda realizes that the day-to-day within-lesson assessment she plans helps shape her instructional practices and provides opportunities to give real-time descriptive feedback to students. However, another purpose for assessment is accountability for learning, which is bolstered by having the fourth grade teachers collectively engage in a consensus-building process to design a common task and documentation forms.

Assessment Across the Unit's Lessons

For content assessment across lessons in the unit, the fourth grade teachers have all agreed to use the end-of-chapter test in the mathematics textbook and to include ELLs at the highest English language proficiency levels. To help equalize the assessment experience, the teachers decide that the students may use the manipulatives and other supports available during instruction. As the students' home languages are supported during mathematics instruction, the beginning and intermediate ELLs are able to use Russian, Vietnamese, or Spanish to paraphrase content expectations and clarify instructions for the test.

The dilemma facing the team is how to measure the unit's language target, especially for Yoshio, Sasha, and Vadir, the ELLs at the lower proficiency levels in English. According to the language target, assessment is to center on the description and comparison of different uses of fractions. Given the findings from the National Literacy Panel that ELLs benefit when oral language is combined with literacy instruction (August & Shanahan, 2006), the fourth grade team has been examining how to infuse academic language into classroom oral discussion (Fisher, Frey, & Rothenberg, 2008; Zwiers & Crawford, 2011). In particular, this past year, team members have focused on the academic language of mathematics (Coggins, Kravin, Coates, & Carroll, 2007; Ernst-Slavit & Slavit, 2007; Slavit & Ernst-Slavit, 2007) and how to convert it into common language assessment (Gottlieb, 2012).

As a result of the discussion, Amanda and her colleagues focus on a performance assessment that captures the students' use of academic language in oral retellings of recipes. For this assessment, recipes would be taken from the class collection, to which each student has contributed one from home. Each student would draw a slip of paper from a paper bag, with a fraction or whole number written on it. Students would be asked to describe aloud how they would change the recipe based on the fraction they chose. Both Amanda and the students would score the oral presentation using a rating scale. All the teachers readily agree this would make a great common assessment. First, the fourth grade team devises an oral rating scale to measure the extent to which the students are using the academic language of fractions. Then the teachers prompt their students to help convert the scale into a student self-assessment; teachers then bring the students' ideas back to their fourth grade team. Figure 3.14 provides a

Figure 3.14 The Language of Mathematics: An Example Rating Scale for an Oral Language Presentation

Where is the Student in the Use of the Academic Language of Fractions? Check a Box.	*At the Finish Line*	*Getting Close*	*Moving Along*	*At the Starting Gate*
1. Uses academic vocabulary to name and compare fractions				
2. Uses comparative language to describe the process of following cooking recipes				

(Continued)

(Continued)

Where is the Student in the Use of the Academic Language of Fractions? Check a Box.	*At the Finish Line*	*Getting Close*	*Moving Along*	*At the Starting Gate*
3. Conveys ideas related to cooking recipes involving comparison of fractions				
4. Uses sequential language to relate the basic steps in cooking recipes with fractions				
5. Explains the use of fractions in cooking recipes to peers				

Other observations of the student's language use:

Student: _____

Teacher: _____

Date: _____

Figure 3.15 The Language of Mathematics: An Example Rating Scale for Student Self-Assessment of an Oral Language Presentation

My Recipe _____ When Speaking to my Class,	*All of the Time*	*Most of the Time*	*Some of the Time*	*Not Quite Yet*
1. I can use denominator and numerator to name fractions.				
2. I can use greater than (>) and less than (<) or most and least when comparing fractions in recipes.				
3. I can compare fractions in recipes.				
4. I can use *first*, *second*, and *last* to show the steps in following recipes.				
5. I can explain how to use fractions in recipes.				

Other things I can do with fractions:

Student: _____

Teacher: _____

Date: _____

sample rating scale for the oral presentation to be scored by the fourth grade teacher team, while Figure 3.15 is a parallel scale designed for self-assessment by individual students.

The information Amanda gleans from assessing her students helps both her and her team to do the following:

1. Augment subsequent instructional units with a more heavy emphasis on academic language
2. Focus on providing students with descriptive feedback based on the lesson's objectives and the unit's targets
3. Reflect every day on the teaching–learning process

REFLECTION ON THE UNIT: LOOKING BACK AND MOVING FORWARD

In her classroom, Amanda is both the language and content specialist. Being endorsed in teaching ELLs, she feels confident in her ability to integrate language and content during instruction, but she carefully teases the two constructs apart during assessment. She realizes the influence of the students' academic language learning on their achievement and is careful to balance the two with her class. Drawing from informational text as well as authentic material for the unit helps her students become skilled mathematicians and encourages them to apply their mathematical knowledge to the world around them.

Amanda is very pleased with her students' performance throughout the unit. Not only do students successfully meet the content and language objectives and targets, they display a high level of engagement. She can't wait to share results with the fourth grade team, so together the teachers can plan for continued learning for their students.

Amanda has been planning units and lessons this way for two years now, after she had a huge "aha" moment during a professional workshop. The presenters asked Amanda and all the participants to carefully examine one or two pages from grade-level textbooks in mathematics, science, and social studies. The goal was to answer the question, "What do students need to know to be able to understand and process the material?" Later, when participants reviewed posters they had made from the analysis of the texts, they were astonished. They couldn't believe all the academic language and linguistic complexity embedded in those short pages! Since that experience, Amanda plans her lessons and units by placing academic language and content at the center—regardless of whether she has ELLs or not.

EXTENDING THE CONTEXT: QUESTIONS AND APPLICATION TO YOUR SETTING

This chapter illustrates one approach to critically examining the interaction between language and content of a mathematics unit on fractions for Grade 4 students from diverse backgrounds. Through the eyes of Amanda, the lessons unfold specifying the expectations for learning for all students, with special attention to ELLs. Realizing the variety of teaching situations and contexts as well as the heterogeneity of student populations that readers are likely to encounter, here are some questions to consider in applying the information and unit plan to other settings:

1. What other materials and supports, including technology, might be used to illustrate the concepts of fractions?
2. What other linguistic and cultural resources might facilitate students' insight into the academic language of fractions?
3. How might the academic language of this unit carry over to other mathematics units?
4. How might the strategies Amanda uses to teach the academic language of this unit apply to other content areas?
5. How might the academic language of fractions be treated by teachers in your grade level or school, in particular, in planning for learning and in assessing what has been learned?
6. How might you, along with your colleagues, visualize the use of academic language within a unit of instruction?

APPENDIX A
THE COVERAGE OF FRACTIONS

Amanda uses multiple resources with every unit she teaches, but she is always careful to refer to the district-selected textbook as a starting place. Here is the scope and sequence from one fourth grade text that claims to correspond to the Common Core State Standards for Mathematics. The following sample Table of Contents for the unit on fractions offers a sense of the depth of its coverage of the topic.

Table of Contents

Everyday Mathematics (McGraw-Hill, 2012)
Level 4. Unit 7

1. Review of basic fraction concepts
2. Fractions of sets
3. Probabilities when outcomes are equally likely
4. Pattern-block fractions
5. Fraction and mixed-number addition and subtraction
6. Many names for fractions
7. Equivalent fractions
8. Fractions and decimals
9. Comparing fractions
10. The ONE for fractions
11. Probability, fractions, and spinner
12. A cube-drop experiment
13. Multiplying fractions by whole numbers

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RESOURCES

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ABOUT THE CONTRIBUTOR

David Slavit is Boeing Distinguished Professor of Mathematics Education and Mathematics at Washington State University Vancouver. Dr. Slavit has conducted extensive research on teacher development, particularly approaches to collaborative inquiry, and students' algebraic understanding at the K–16 level. He has participated in numerous partnerships with teachers, schools, and districts on a variety of educational issues, and is the former director of the Masters in Teaching Program at WSUV. Dr. Slavit has over 60 publications and has received $5 million in external support for research and teacher professional development.