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Implementation of Informal Formative Assessment in An Elementary Math Classroom: A Case Study

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Abstract

A large body of research has shown the effectiveness of formative assessment on student learning. Yet research on teachers' implementation of formative assessment is relatively underdeveloped. In addition, there has been a lack of effective instruments for observing teachers' formative assessment practices. This study focuses on the ongoing informal formative assessment and explores the nature of one experienced elementary teacher's formative assessment practices by drawing on a sociocultural perspective and the tool of Formative Assessment Rubrics, Reflection, and Observation Protocol. Primary data sources include classroom observations, interviews, and artifacts. Using inductive and deductive coding approaches, the study found the importance of creating a classroom culture of valuing and foregrounding student ideas when teachers communicate learning targets and elicit students' thinking. In addition, the study sheds light on the teacher's questioning practice with variations during informal FA. The study has implications for future research.

Keywords:

Informal Formative Assessment, Implementation, Sociocultural Perspectives, Mathematics

Introduction

As an essential component of core teaching practices and high-leverage teaching practices (Gotwals & Cisterna, 2022; Polly et al., 2016), formative assessment (hereafter FA) has received more and more attention in teaching and teacher education. FA, which refers to assessment for learning in the study, is "a planned, ongoing process used by all students and teachers during learning and teaching to elicit and use evidence of student learning to improve student understanding of intended disciplinary learning outcomes and support students to become self-directed learners" (Council of Chief State Officers [CCSSO], 2017, p.2). If used effectively, FA can improve student achievement (Black & William, 1998a; 1998b) and "provide teachers and their students with the information they need to move learning forward" (Heritage, 2007, p.140). Researchers noted the positive effects of using FA on student achievement in math (Klute et al., 2017; Pinger et al., 2018; Silver & Smith, 2015). The use of FA received the highest score in math classrooms compared to other subjects like literacy and arts

when assessing the effects of FA on students' learning outcomes (Lee et al., 2020). Moreover, the informal FA, which is a "socially situated activity", allows teachers to gather reliable and solid evidence on students' learning continuously in their daily class activities (Ruiz-Primo, 2011, p.16).

However, there seems to be a gap between research advocating the effectiveness and significance of FA and the understudied situation concerning classroom teachers implementing FA (Box et al., 2015). Compared with the body of research investigating the effectiveness of FA, studies assessing how classroom teachers perform FA, including informal FA, are still underdeveloped due to the complexities of implementing FA (Philhower, 2018; Veon, 2016). Previous studies have found that teachers face challenges when incorporating FA into their classrooms. These challenges can include struggling to implement FA effectively or only utilizing it to a limited extent (Bennett, 2011; Van der Kleij et al., 2018). Factors that influence a teacher's implementation of FA include their (a) knowledge and skills in providing effective feedback and asking the right questions to facilitate classroom discussion, (b) collaboration opportunities between teachers, and (c) teacher beliefs and self-efficacy in using assessment for learning (Schildkamp et al., 2020; Yan et al., 2021). Meanwhile, classroom teachers' FA practices are understudied because there is a lack of effective tools to observe these practices accurately (Yan & Pastore, 2022). More specifically, there is a need to assess the degree to which teachers prioritize students' ideas and contributions during FA. Nonetheless, questions concerning teachers' understanding of FA and how teachers perform FA coherently (or not) have been raised. Consequently, it is the role of this research to further uncover the "black box" of teachers' FA practices in classrooms.

The study focuses on the teacher's informal FA. Drawing on a sociocultural perspective of FA, which emphasizes student involvement and students co-constructing knowledge during the interaction, and the observation and reflection tool of the Formative Assessment Rubrics, Reflection and Observation Protocol (FARROP) (Wylie & Lyon, 2016), the study investigates an experienced elementary teacher's FA practices in a fifth-grade math class. This study concerns informal FA in-moment use in the math classroom. Specifically, the following research questions guide this study:

1. What is the nature of an elementary teacher's informal FA practices during a math unit on division with whole numbers and decimals?

2. What interactions and practices are connected to the elementary teacher's informal FA in her fifth-grade math classroom?

Conceptual Framework and Literature Review

Assessment From a Sociocultural Perspective and The Characteristics of Formative Assessment

The notion of FA in this study refers to assessment for learning (Schildkamp et al., 2020), which is "part of everyday practice by students, teachers, and peers that seek, reflect upon and respond to information from dialogue, demonstration, and observation in ways that enhance ongoing learning" (Klenowski, 2009, p.264). According to teachers, FA "allows them to be responsive to students' needs in the moment and plan accordingly" (Martin et al., 2022, p.421). The conceptualization of FA can be associated with different underlying theoretical perspectives (Briggs et al., 2012; Janeth, 2019). From a sociocultural perspective, assessments "recognize the importance of sociocultural activity as a vehicle for integrating these desired outcomes, and it anticipates the variability in performance that can occur across particular situations" (Smith et al., 2004, p.40). In other words, FA is based on the underlying assumption students construct knowledge through social interactions (Black & William, 2009; Gipps, 1999). Both teachers and students are jointly responsible for the quality of learning and teaching during FA (Kim, 2019).

In addition, to leveraging student participation experiences during FA, it is important to create a classroom culture characterized by openness and acceptance, in which students feel safe and comfortable working with teachers and their peers (Box et al., 2015). In the meantime, the use of FA, in turn, can enhance the collaborative learning environment and empower student-teacher relationships (dos Santos Barreto & de Oliveira Soares, 2020). Performing effective FA from sociocultural perspectives echoes Crossouard's (2009) work in prioritizing students' roles. According to Crossouard (2009), effective mathematics instruction demands that teachers use learner-oriented tasks and activities to support students in becoming powerful mathematical thinkers.

Regarding the characteristics and process of FA, Black and Wiliam (2009) categorized FA into five stages: (1) clarifying and sharing learning intentions and criteria for success; (2) engineering effective classroom discussions to elicit evidence of student understanding; (3) providing feedback that moves students' learning forward; (4) activating students as instructional resources for one another; and (5) activating students as owners of their learning. The Council of Chief State School Officers (CCSSO, 2017) pointed out that effective FA should embed the following five essential practices in the classroom: (1) clarifying learning goals and success criteria; (2) eliciting and analyzing evidence of student thinking; (3) engaging in self-assessment and peer feedback; (4) providing actionable feedback; and (5) using the

evidence and feedback to move student learning forward. The FA process, based on the above definitions, can be categorized as three questions that teachers and students should ask themselves: "Where are we going?" "Where are we now?" and "How do we get to where we are going?" (Gotwals & Ezzo, 2018). These questions are more closely examined in the following paragraphs.

Where Are We Going? Articulating Learning Targets

Clear learning targets can guide both teaching and learning (Konrad et al., 2014). The National Council of Teachers of Mathematics (NCTM, 2014) pointed out that communicating learning targets can guide teachers' instructional decision-making and promote students' awareness of learning ownership to move their current learning forward. Without clearly communicating learning targets to students, teachers are unlikely to assess students effectively and accurately (Chappuis et al., 2009; Marzano, 2013; Moss et al., 2011).

Where Are We Now? Gathering Evidence About Student Learning

When teachers provide students with opportunities to fully demonstrate what they have learned, the critical data that teachers gather can inform student-teacher interactions, and, thus, help teachers and students pinpoint the gap between what students are expected to learn and what they currently understand (Heritage, et al., 2009). Usually, evidence of student learning consists of everything students do such as group conversation, asking and responding to questions, or even students' confused looks (Leahy et al., 2005). In a mathematics class, there are various opportunities for a teacher to collect and gather evidence of student learning. This study focuses on teachers gathering student learning evidence using questioning practices in whole-class discussions. The moment-by-moment basis of FA allows teachers to collect real-time, rich, and flexible data via conversations and interactions (Heritage et al., 2009).

How Do We Get There? Actions Based on the Evidence of Student Learning

There are two aspects regarding teachers' actions after gathering the student learning evidence: (1) feedback to students and (2) instructional modification. The format of feedback to students can be one-to-one, group-based, or whole-class-based. Usually, a teacher's response to a student's written work is one-on-one and often occurs after the student has turned in their work; but feedback during classroom discussion can be given immediately (Black & William, 2009).

According to Hattie and Timperley (2007), teachers' feedback can be categorized into four levels: (a) feedback not explicitly tied to assessment tasks (e.g., good job); (b) feedback relevant to student task performance; (c) feedback about task processing; and (d) feedback for student self-regulation. When students receive feedback (e.g., at the process level) with "cues to directions for searching and strategizing" or that "leads to further engagement with or investing further effort into the task," they feel more powerful and confident (Hattie & Timperley, 2007, p.102). Teachers should provide feedback to students that is clear, practical, transparent, useful, easy to understand, timely, and consistent (Wiggins, 2012). This will ensure that the feedback is effective for students' learning. The study examines how teachers provide feedback to students during classroom discussions.

Informal Formative Assessment and Its Implementation in Math Classrooms

Informal FA is a socially situated "assessment conversation" (Ruiz-Primo, 2011, p.16). Usually, informal FA is more spontaneous and can occur in various student-teacher interactions, such as whole-class, small-group, or one-on-one settings (Ruiz-Primo & Furtak, 2007). Studies have revealed that FA holds significant promise in aiding student learning. As a result, it has gained more and more attention from educators and researchers. During informal FA, teachers gather information and react to it "on the fly" by considering students' responses (Ruiz-Primo & Furtak, 2007; Ruiz-Primo, 2011). Using informal FA allows teachers to gather reliable and solid evidence on students' learning by drawing on their daily class activities and reacting to students' responses using flexible and multiple modes of feedback (e.g., oral text, written text, and visuals; Ruiz-Primo, 2011). In addition, informal FA allows teachers to explicitly elicit students' thinking and recognize students' language use in an unobtrusive manner (Ruiz-Primo & Furtak, 2007; Ruiz-Primo, 2011).

To better illustrate the informal FA process, researchers proposed four discourse moves: (a) teachers asking questions, (b) students responding, (c) teachers recognizing students' responses, and (d) teachers using the information they collected to support student learning (Ruiz-Primo & Furtak, 2007). The core of the discourse moves during informal FA, to a large extent, echoes the higher-level questioning patterns that Herbel-Eisenmann and Breyfogle (2005) proposed, where listening to students' responses and reacting to students' ideas are highlighted.

According to Herbel-Eisenmann and Breyfogle (2005), three types of questioning patterns govern the student-teacher interactions in math classrooms: Initiate-Response-Evaluate (IRE), funneling and focusing patterns. Funneling questioning "occurs when the teacher asks a series of questions that

guide the student through a procedure to a desired end" (Herbel-Eisenmann & Breyfogle, 2005, p.485). The focusing questioning, in contrast, requires teachers to listen to students' responses and provide students with opportunities to explain their thinking, rather than rushing to obtain a desired answer (Herbel-Eisenmann & Breyfogle, 2005). Teachers should actively engage with students' thinking and emphasize their role in constructing knowledge. Failure to do so can lead to missed chances for assessing students' understanding (Box et al., 2015).

Yet, when it comes to the implementation of informal FA in elementary classrooms, teachers' FA practices tend to be inconsistent (Veon, 2016). For example, teachers were likely to use FA to elicit students' responses and clarify expectations more frequently than to analyze students' responses (Veugen et al., 2021). In addition, when providing follow-up instructions, teachers, sometimes, did not fully react to students' ideas after diagnosing gaps in students' thinking (Fobes et al., 2015). Therefore, to have an in-depth understanding of teachers' informal FA practices, it is crucial to examine the interactions between teachers and students. This includes observing how teachers recognize and respond to students' responses.

Methods

According to Yin (2003), a case study is an empirical inquiry that explores contemporary phenomena in real-life contexts. I adopt an exploratory case study to investigate the nature of one focal teacher's implementation of informal FA in a natural setting. An exploratory case study is often used to answer "what" and "how" questions and to "explore any phenomenon in the data which serves as a point of interest to the researcher" (Zainal, 2007).

Context and the Participant

The School Site

The school where the focal teacher worked is in a college town in the upper Midwestern United States, with forty percent of the student population in Rochester Elementary (pseudonym) receiving free or reduced lunch. The school provides education for students from preschool through to fifth grade. This school adopted a math program called Math Expression, which is an inquiry-based K-6 curriculum built on National Science Foundation (NSF) funded research. This curriculum highlights learning math through real-world situations and multiple ways to solve problems.

The Focal Teacher

Mrs. Grey (pseudonym), the focal teacher, has been teaching for over 20 years in elementary and middle schools in urban and suburban areas. I chose Mrs. Grey's math class because of its inquiry-based math curriculum, where a rich math discussion is highly advocated. This context allows me to see how Mrs. Grey brings the math discussion to her class and how well she performs informal FA. In addition, a teacher's teaching experiences and reflection on their instruction are fundamental for supporting students' learning. I chose Mrs. Grey as my focus teacher due to her extensive teaching experience and reflectivity. Mrs. Grey connects her teaching practices with current research and seeks self-improvement in her teaching methods. For example, she conducted action research to investigate gender equity issues in her math class, presented her research at conferences, and mentored intern teachers from the local university. Mrs. Grey's extensive teaching practices allowed me to observe how an experienced elementary teacher performs informal FA, and to examine how findings in the study may inspire novice elementary teachers' FA practices.

Data collection

Before data collection, the study first gained an Institutional Review Board (IRB) approval from a large research university in the Midwest of the United States. After receiving approval for the study, I collected consent forms from the classroom teacher and students' guardians. Primary data sources that I gathered included classroom observations, interviews, and artifacts. I visited Mrs. Grey's math class for a whole unit for around six weeks to observe Mrs. Grey's informal FA practices continuously. I've observed the class twelve times. Each observation lasted around an hour. In total, about twelve lesson hours were observed. The math unit focuses on division with whole numbers and decimals.

Class observations

The fifth-grade math classroom that I observed had twenty-nine students, with seven of them being multilingual learners. Before my observation, the classroom teacher informed all the students about my presence. However, one student's parents decided not to participate in my study. To ensure the student's privacy, the teacher placed the student on the right side of the classroom, away from the camera's view. During my observation, I adopted a direct observation approach (Yin, 2003) and sat in the back of the classroom without interventions on Mrs. Grey's instruction. The class observations allowed me to better understand the context of Mrs. Grey's informal FA. It also gave me clues and enlightenment on what follow-up questions to ask about her teaching practice. All the classroom observations were conducted in the same class, and video recorded. In addition, I took field notes about the teacher's instructional moves and her interactions with students in the math class. In total, I collected 12 teaching videos, with each of the videos lasting around 65 minutes.

Interviews

I first conducted semi-structured interviews with the teacher: prior to, in the middle of, and at the end of her unit teaching. The semi-structured interview protocol includes fifteen questions. The foci of the interview questions are (1) Mrs. Grey's professional learning opportunities on classroom assessment; (2) Mrs. Grey's understanding and perceptions of FA; and (3) the challenges that Mrs. Grey might encounter when assessing her students. Then I conducted modified stimulated recall interviews (Sherin & van Es, 2005) and asked questions about the specific instructional moves made by Mrs. Grey during her informal FA. The instructional moves that I selected focused on Mrs. Grey's questioning practices. All the interviews were conducted in person. I audio-recorded all the interviews using recording software on a password-protected computer. Each interview lasted approximately 30 minutes.

Data analysis

In the study, I used an inductive coding approach (Strauss & Corbin, 1998) to identify emergent themes. I used a deductive coding approach, which refers to an approach that "employs the ideas from a theoretical framework or other driving ideas" (Galman, 2016, p.24), to look for patterns in Mrs. Grey's informal FA practices. To ensure the reliability of the qualitative data, I employed data triangulation. This involved utilizing multiple sources of data in my study, which included field notes, video recordings, and interviews. The inclusion of these various sources enabled me to gain a thorough understanding of Mrs. Grey's FA practices. In the meantime, it allows me to see potential conflicts and consistency of my observation notes, my analysis of Mrs. Grey's FA practices, and her understanding and reflection upon her instructions.

Deductive coding

Why I used FARROP in deductive coding

Using the FARROP (Wylie & Lyon, 2016) as an analytic tool enabled me to observe Mrs. Grey's informal FA practices more explicitly and concretely based on its predeveloped dimensions. According to the FARROP (Wylie & Lyon, 2016), FA consists of 10 dimensions. Each dimension includes five levels concerning how well a teacher implements FA. The five levels include "not observed," "beginning," "developing," "progressing," and "extending". The ten dimensions of FA can be integrated into three stages of FA: (1) Where are we headed, (2) Where are we now, and (3) How do we close the gap? Naturally, each stage does not represent a linear process, rather they are coherent and systematic cycles (Gotwals & Cisterna, 2022).

As Table 1 shows, the FARROP dimensions I and II answer the first question concerning where we are headed; dimensions III, IV, and V answer the second question of where we are now; and dimensions VI, VII, and VIII answer the third question of how to close the gap. Dimensions IX and X can be incorporated into each stage of FA.

During the data analysis, I did not include the FARROP dimensions V and VII. Dimension V was not included because Mrs. Grey's whole-class discussions did not present much evidence of students' performing self-assessments. Dimension VII was not included because the definition of "descriptive feedback" in the FARROP rubric (Wylie & Lyon, 2016) focuses on formal written feedback, while this study concerns Mrs. Grey's informal FA, which is primarily oral-based and spontaneous.

How I coded data using the FARROP protocol

For Mrs. Grey's informal FA practices, I concentrated on the whole class discussion. The whole class discussion is also what I was able to best hear with the videos I collected. I first went through each video and noted instances of each dimension of FA. For example, I identified sentences such as "I can...," "Today we will talk about...," and "Our goal is..." as evidence of whether Mrs. Grey communicated learning targets with students explicitly in each lesson. I then wrote notes about what happened. Sometimes I transcribed the conversation between Mrs. Grey and her students. Following that, I used the FARROP to determine the level of Mrs. Grey's practice across lessons. For example, I noticed a "progressing" level in her practice of clarifying learning targets. Similarly, drawing on the FARROP protocol, I marked Mrs. Grey's expertise levels in other dimensions of FA and entered them into a spreadsheet. See Table 2 for an example of the marked expertise levels of Mrs. Grey's FA practices.

In light of the levels that I marked in each teaching video, I compared and looked across all the recorded lessons for patterns and themes that illustrated how well Mrs. Grey enacted informal FA through the math unit. I wrote memos about the cross-video analysis to document preliminary findings on Mrs. Grey's informal FA practices. An overarching pattern that emerged was the wide range of Mrs. Grey's expertise levels in implementing informal FA. These variations include her practices in communicating learning targets and eliciting student thinking using questioning techniques.

Inductive coding

To make sense of patterns generated from deductive coding, I first conducted open coding (Strauss & Corbin, 1998) to look for emerging concepts and categories that might explain the ranges and variations in Mrs. Grey's informal FA practices. To do so, I moved iteratively between the field notes, interview transcripts, and teaching videos, and labeled concepts in the margins of the interview transcripts. Following

Table 1.

Dimensions of FA According to The FARROP (Wylie & Lyon, 2016)

Teachers' Expertise Levels in Performing FA	Dimensions of FA (FARROP, Wylie & Lyon, 2016)	FA Process
Not observed Beginning Developing Progressing Extending	i. Learning goals	Stage 1: Where are we going
	ii. Criteria for success	
	iii. Tasks and activities that elicit evidence of student learning	Stage 2: Where are we now?
	iv. Questioning strategies that elicit evidence of student learning	
	v. Self-assessment	
	vi. Extended thinking during discourse	Stage 3: How do we close the gap?
	vii. Descriptive feedback	
	viii. Peer feedback	
	ix. Using evidence to inform instruction	Embedded into all three stages
	x. Collaborative culture of learning	

Table 2.

A Sample Cross-Video Analysis Using the FARROP (Wylie & Lyon, 2016)

Observation Dates / Dimensions	Communicating Learning Goals (Including Success for Criteria)	Tasks and Activities to Elicit Evidence of Learning	Questioning Strategies to Elicit Evidence of Learning
Video (Feb.13)	Beginning	Extending	Between Progressing and Extending
Video (Feb. 14)	Not Observed	Extending	Progressing
Video (Feb.19)	Beginning	Extending	Between Progressing and Extending
Video (Feb. 20)	Between Developing and Progressing	Extending	Progressing
Video (Feb.22)	Progressing	Extending	Between Developing and Progressing
Video (Feb.26)	Not Observed	Between Progressing and Extending	Developing
Video (March 4)	Progressing	Progressing	Progressing
Video (March 5)	Developing	Progressing	Between Developing and Progressing
Video (March 6)	Progressing	Extending	Between Developing and Progressing
Video (March 7)	Extending	Extending	Between Progressing and Extending
Video (March 8)	Developing	Between Developing and Progressing	Between Progressing and Extending

this, I categorized those concepts into groups based on the common purpose of Mrs. Grey's instructional moves. Using concepts that emerged from the open coding of the interview data, I returned to the teaching videos and looked into interactions between Mrs. Grey and her students. I transcribed video clips in which I found higher and lower levels regarding how Mrs. Grey communicated learning targets and elicited student thinking during her informal FA practices. I then used the interview data, field notes, and video transcripts to make sense of Mrs. Grey's lower and higher practices. The inductive coding showed two themes emerging from Mrs. Grey's informal FA practices: (a) Valuing students' ideas, and (b) funneling questioning.

Findings

My observation aligns with Mrs. Grey's comment in which she stated, "Discourse in our classrooms is a huge part of that formative assessment.....to drive instruction and make decisions for the next day". The discourse that Mrs. Grey mentioned aligns with the nature of informal FA for being socially situated and assessment-conversation-based. According to Mrs. Grey, using class discussions allows her to understand student learning in an "organic way." It can also develop students' skills in "discourse capacity."

Below I first illustrate what Mrs. Grey values in implementing informal FA. I then illustrated what her informal FA practices looked like and how her practices aligned (or did not align) with her reported values.

Create a Classroom Culture of Valuing Student Ideas

One theme that emerged from the interview data was Mrs. Grey's intention to create a classroom culture that values student ideas and contributions. Mrs. Grey believed that only in a classroom where students feel that teachers value their contributions will students feel safe and comfortable to participate. When I asked Mrs. Grey how she supported students participating in class discussions, she said,

> *The other thing that I've given them is there are times when I ask questions and their response is a question. So they know that I do not expect them to give me an answer every time they need clarification. It's safe to say I need to know more about and then take charge of the conversation that way, you know, that's a valuable contribution. As they know I value it, and their peers value it, it is all about practice and helping them feel comfortable with that. [Interview on March 13, 2019]*

According to the interview excerpt, Mrs. Grey attempts to create a classroom culture of valuing students' ideas in a variety of ways, for example, allowing students to respond with questions and acknowledging students' ideas.

Enactment of Informal FA

I explored two specific aspects regarding Mrs. Grey's enactment of informal FA. The first one is on how Mrs. Grey communicated learning targets with students, which covers the FARROP dimensions I and II (i.e., clarifying learning goals and criteria for success). The second aspect is about how Mrs. Grey elicited and responded to students' ideas, which covers the FARROP dimension IV (questioning strategies), and dimension VI (extending students' thinking during discourse). The FARROP dimension X (collaborative culture of learning) was integrated into both two aspects of Mrs. Grey's informal FA implementation.

These two practices emerged, through analysis, as the main ways in which Mrs. Grey enacted informal FA. In the descriptions, I identify the relationships between higher levels of these informal FA practices and how Mrs. Grey used these practices to create a classroom culture that values student ideas. Conversely, I provide instances of lower levels of informal FA practices in Mrs. Grey's class and how those practices might not foreground students' ideas.

Communicating Learning Targets With Students

Mrs. Grey's practices of communicating learning targets with students ranged from "not presenting at all" to "extending." The overall trend of Mrs. Grey's practices in communicating learning targets was between "developing" and "progressing" (see Table 2). In some cases, Mrs. Grey demonstrated higher-level practices, in which she foregrounded students' ideas and provided opportunities for them to internalize learning targets. However, in some lessons, she demonstrated a lower-level practice, in which students did not receive sufficient opportunity to express ideas and internalize learning targets.

Higher-level practices of communicating learning targets

In the higher-level practices, Mrs. Grey not only made connections to students' prior learning experiences, but she also provided students with opportunities to internalize learning targets. According to the FARROP (Wylie & Lyon, 2016), the opportunity for students to internalize learning targets includes debriefing the purposes of a lesson and creating spaces for students to create learning targets with the teacher. In the study, the approaches that Mrs. Grey created opportunities for students to internalize learning targets are (1) activating students' prior knowledge and introducing students' ideas to the class discussion, (2) reviewing and revisiting what students learned at the end of lessons, and (3) supporting students' learning autonomy. Below I explain how Mrs. Grey communicated learning targets with students using three examples.

Table 3.

I Believe That Someone Said Yesterday...

Transcripts	Comments
Mrs. Grey: Okay, we will take a look at page 223. At the top of page 223, why did they give us this information (circled 1,715 ÷ 35 = 49), Lucas (non-EBs, a pseudonym)? Lucas: Because all of those are similar, (paused), they are [the] same numbers but put decimals in different places.	
Mrs. Grey: So I can and you can right away put 49 on the top of them. And I believe that someone said yesterday that the strategy they used is to ignore the decimal and figure out where it goes later. Whole class: Hmm.	Mrs. Grey introduced a student's idea that was discussed yesterday.
Mrs. Grey: So that is what we're going to practice today. So if I am looking here (circles the divisor of 35) and 35 is my divisor and 17 is the whole part of my dividend, do I know how big the magnitude of my equation is going to be? Nisha, what would you know about 17 divided by 35? Whole class: It cannot be divided.	Drawing on the student's ideas that they discussed yesterday, Mrs. G pointed out that this would be the focus of today's lesson.
Mrs. Grey: You can divide. What do you know about that, [Nisha], I just wrote 17 divided by 35 in a different form to help you. Nisha: < > Mrs. Grey: Say it again. Nisha: 7 multiple 5 is 35.	
Mrs. Grey: That is true. The 7 multiple 5 is 35. But I do not know whether that can help us to figure out how big our answer should be. I have 17 divided by 35. Tasnime, do you have ideas about that? What do you know about 17 divided by 35? Tasnime: < >	
Mrs. Grey: (Walks toward Tasnime trying to hear what she said) Maybe equal to 49? Okay, other thoughts about this, 17 divided by 35 (Mrs. Grey points to 17 in the divisor of 17.35), Franklin? Franklin: 17 divided by 35, then, um (paused). Mrs. Grey: How many 35s in 17? Franklin: Less than 1.	
Mrs. Grey: Less than 1, right? How do we make the 49 less than 1 in decimal form? Tasnime, how to make the 49 less than 1? (Waits for a few seconds) Where do I put the decimal? After the 9, between the 4 and 9, or in front of the 4? Tasnime: In front of the 4. Mrs. Grey: In front of the 4. Does it make sense, Tasnime, that the seventeen thirty-fifth (i.e., 17/35) is about half (Mrs. G wrote down 17 ÷ 35 ≈ ½)? Whole Class: Yeah. Mrs. Grey: It does, right? So 49 hundredths (i.e., 0.49) is our answer making sense. How about the next one?	
Videotaped on March 7, 2019	

Example 1: Introducing Students' Ideas Into Class Discussions

Table 3 shows how Mrs. Grey built on students' knowledge activation and guided students to think about learning targets.

In this example, Mrs. Grey intended to guide students to learn the learning target. Instead of simply posting the lesson focus on the whiteboard or briefly mentioning it, Mrs. Grey began by discussing a math task in the student's activity book. Mrs. Grey first invited Lucas to think about the math task's clue (Mrs. Grey circled 1,715 ÷ 35 = 49 on the whiteboard). Then, Mrs. Grey progressed a further step based on Lucas's response and intentionally introduced Lucas's idea to the whole class before she told the class what the learning target was. By doing so, students could feel that Mrs. Grey valued their contributions because she remembered what students had said in the previous lesson. In the meantime, the way that Mrs. Grey foregrounded students' ideas played a role in capturing the students' attention.

Example 2: Revisiting and Reviewing Learning Targets.

Another approach that Mrs. Grey used was reviewing and revisiting the learning target. In the conversation episode presented in Table 4, Mrs. Grey asked her students to reflect on what they had learned at the end of the lesson.

This example shows that Mrs. Grey guided students to reflect on what they learned. She first explicitly asked students reflective questions such as "What is the purpose of what we did today." This move provided students with opportunities to revisit the learning goal of this lesson. Then, Mrs. Grey guided students to think about the algorithm method (i.e., digit by digit) that they learned. To further check students' thinking,

she invited more students, for example, Tasnime and Greg, to join the conversation. After hearing Tasnime's responses, Mrs. Grey revoiced Tasnime's answers. Next, she invited Greg to think about whether there is only one way to place the decimal. The purpose of this invitation was to emphasize that students can use multiple ways (i.e., different algorithm methods) to solve division problems, which is an essential component of this lesson's learning goals.

Example 3: Supporting Student Learning Autonomy.

Mrs. Grey's practice of presenting learning targets was

Table 4.
What Is the Purpose of What We Did Today?

Transcripts	Commentary
Mrs. Grey: Before you put your pencils down, I am going to ask you what is the purpose of what we did today. What did you get out of it? Lucy (non-EBs, a pseudonym), what did you get out of it? Lucy: I think what I got out of it is how to use my decimal what (paused) what to do.	Mrs. Grey asked students to reflect on the lesson's purpose and what they had learned at the end of today's lesson.
Mrs. Grey: It was what to do with them. We did not figure any problem out from the top to the bottom, right? Whole Class: Yeah Mrs. Grey: We used our? Lucy: I used digit by digit. Mrs. Grey: We used the way to figure out every digit with the decimal and some that we did not with the decimal. So we did compare problems as you were saying.	Mrs. Grey guided students to think about one of the algorithm methods – digit by digit – that they practiced, which is an essential component of the math curriculum.
..... Mrs. Grey: Awesome. Tasnime, what did you get out of what we did today? Whole Class: Where to move [when] dividing by the decimal? Mrs. Grey: So you know where to put the decimal? Whole Class: Yes	Mrs. Grey invited another student, Tasnime, to share her takeaway.
Mrs. Grey: Awesome. Is there just one way, Greg (non-EBs a pseudonym)? Whole Class: No	Mrs. Grey invited student Greg to join to show that there are multiple ways to solve the division problem.
Mrs. Grey: We went back and forth, some [algorithm method] worked better than some others. But they [the algorithm methods] work for all of them [the division problems].	Mrs. Grey provided a brief conclusion.
Videotaped on March 7, 2019	

Table 5.
Who Is in Charge of Your Learning?

Transcripts	Comments/Notes
Mrs. Grey: Fifth graders, what are we doing right now? What are we doing right now in this math class? Whole Class: Dividing.	
Mrs. Grey: We are dividing a decimal by decimal number, right? What part of the lesson? Who is in charge of your learning? Student A: You. Student B: No, yourself. Student C: Oh. Student D: Ourselves.	Mrs. Grey invited students to think about their learning autonomy.
Mrs. Grey: We just had an amazing discussion about a couple of them. It is your responsibility to attend to that discussion, right? Whole Class: Yes.	Mrs. Grey talked about how to be a student.
Mrs. Grey: You learn only if you are willing to think about it. I am not in charge of your learning right now. I am facilitating your learning. And I asked you questions trying to let you think. And I have been doing that since September. You probably do not remember what math was like before you came to Mrs. G's class. Whole Class: It was bad. Mrs. Grey: I would not say it was bad. I would not say that. It is just not feeling like this. We are talking about math right now. And if you are not listening, you are not talking about it either, right? Whole Class: Yes.	Mrs. Grey explained to the students the purpose of her question.
Videotaped on March 7, 2019	

not limited to focusing on the math content. There were moments when she encouraged students to think about learning autonomy. Through a conversation presented in Table 5, Mrs. Grey asked students to reflect on who was in charge of their learning and encouraged students to think about how to become responsible and independent thinkers.

As the excerpt shows, Mrs. Grey invited students to think about their learning autonomy by asking "What are we doing right now in this math class?" and "Who is in charge of your learning"? After noticing that some students still perceived the teacher as the authority figure to charge their learning, Mrs. Grey then communicated with students about how to become a self-regulated student and, in the meantime, stated her role as a facilitator.

Lower-level practices of communicating learning targets

There are some instances where students did not have sufficient opportunities to internalize learning targets during Mrs. Grey's informal FA. In the lower-level practices, I noticed that how Mrs. Grey communicated learning targets with students was brief and vague, for example, simply positing the criteria for success on the slides. There was no further discussion on "why" students are expected to learn the lesson's content, and "how" students could achieve the learning goal. The assessment conversation in Table 6 presented an example of the teacher's lower-level practice of communicating learning targets.

In this conversation, Mrs. Grey verbally presented learning targets near the beginning of the lesson. However, there was no further explanation of why the estimation was important. In addition, the connection between today's lesson and students' learning in a larger scope was not addressed. The variations of Mrs. Grey's practice in communicating learning targets can be influenced by contextual factors such as limited instructional time. During my interviews with Mrs. Grey, she said,

> *I think that it would be helpful to provide learning targets. It always comes down to time and how much time I have to get things done. This year we have never had as many snow days as we have had. We have missed ten days of school. That is two weeks of instruction in the heart of our instructional time.....As an instructor, I am nervous about the impact that's going to have. [Informal Interview on March 26, 2019]*

Based on the interview excerpt, it is clear that Mrs. Grey understands the significance of communicating learning goals to students. However, it seems that she had to find a way to manage her instructional time while consistently delivering the learning targets.

Eliciting Student Thinking Using Questioning Practices

The previous section focused on Mrs. Grey's practices of communicating learning targets, namely "Where are we going". This section addresses two main points: "Where are we now," which involves gathering evidence of student learning, and "How do we get there," which emphasizes teachers providing feedback to move student learning forward. Specifically, this section focuses on how Mrs. Grey elicited students' thinking using the questioning strategy.

According to Mrs. Grey, the questioning practices not only help her to "understand where students are at their day" but also help students to "understand that they might not understand" (interview on March 13, 2019).

In Mrs. Grey's classroom, the questioning strategy has two purposes: gathering evidence of student learning and providing feedback on students' responses. The follow-up questions asked by Mrs. Grey can also be seen as her way of giving feedback to the students. A "funneling" questioning pattern emerged through the inductive coding. To recap, the "funneling" questioning pattern refers to teachers guiding students to a desired end by asking a series of questions (Herbel-Eisenmann & Breyfogle, 2005). Mrs. Grey's "funneling" questioning practices ranged from a lower level to a higher level, depending on how much she incorporated students' ideas.

Higher level practices of funneling questioning in eliciting student thinking

In the higher level "funneling" questioning practices, Mrs. Grey listened to students' responses intentionally and provided students with opportunities to express their thinking. Here I consider Mrs. Grey's questioning practices to show a higher level "funneling" questioning pattern, rather than the "focusing" questioning pattern because opportunities to excavate the students' deeper thinking are still missed occasionally during Mrs. Grey's informal FA practices.

Table 7 shows how Mrs. Grey created opportunities to illustrate students' thinking when they were discussing the math division task of 1,715 ÷ 3.5.

In this example, Mrs. Grey began by posing a few targeted questions, such as "How can I make this close to 6?" These questions helped clarify her initial query, which was "What is the significance of this?" After receiving a response from the student, Mrs. Grey followed up with another question: "Why do you believe it is encompassing the entire thing?" This allowed for the collection of evidence regarding student learning and fostered student participation. Kevin, one of the students, provided an answer to her "why" question. After Kevin responded, Mrs. Grey affirmed his thoughts by saying, "So you want me to do this? Is that what you mean?" She then drew on

Table 6.

Our Goal Is To Use Estimation to Solve Longer Division Problems

Transcripts	Comments
Mrs. Grey: We will talk more today about using estimation to solve larger problems. Tasnime, would you be able to help me? (Managing student behavior). So our goal is to use estimation to solve longer division problems. I want to start by looking at the top of page 190. [1]Whole class: Nine	Mrs. Grey presented the focus of today's lesson at the beginning of the lesson.
Mrs. Grey: Ninety-nine. So if you'd like to have it close where you are on page 199. On page 199 it shows you heard me use the word forgiving (this word may not be recorded and transcribed accurately) to describe the expanded form algorithm you can use, right? Whole class: Uh-huh.	Mrs. Grey transitioned to discussing a math task in a student exercise book. No further explanation about the learning target was offered.
Mrs. Grey: If we look here, using the traditional algorithm, and we have 93 left in our divisor as 85 (managing student misbehaviors), what's wrong here, Greg? Whole class: Hmm... (paused) Mrs. Grey: 85 times 5 is 425, right? That was where this came from. [2]Greg (student): Oh, he put the [3]< > in the wrong place.	Mrs. Grey did not create an opportunity for students to internalize learning targets in the discussion.
Mrs. Grey: No, it is okay. If we were using the expanded form algorithm that we have been using, it looks like this, right? But those used the digit-by-digit algorithms. If 85 is my divisor (Mrs. G writes 5,185 ÷ 85), how many 85s in 51? (Ms. Grey continued to discuss the division problem posted at the top of the student activity book).	
Videotaped on February 20, 2019	

Table 7.

Why Do You Think It Is Wrap a Whole (i.e., Rounding Up)

Transcripts	Comments
Mrs. Grey: How about number 5? If we are thinking about the whole number 17 divided by 3, what would that be about, Kevin (non-EBs, a pseudonym)? 17 is close to 18, right? And 18 divided by 3 is 6, right? How could I make this close to 6? Am I going down or wrapping it [490] whole? (Mrs. G and the students were talking about whether to round 490 up to 500 or go down). Whole Class: Wrap a whole.	Mrs. Grey initiated questions.
Mrs. Grey: Why do you think it is wrap[ping] a whole? Kevin: Because it is not close to the actual answer. Mrs. Grey: I would disagree that it is not close to the actual answer. Kevin: I mean 100 away, 110 away.	Mrs. Grey asked students to explain why they think it is wrapping a whole. Then Mrs. Grey provided negative feedback showing she disagreed with students' ideas.
Mrs. Grey: So you want me to do this? Is that better? Whole Class: Yeah. Mrs. Grey: But is it useful for reasoning what the answer is? Student A: No. Student B: Just to leave the number. Student C: 18 is too big. Whole Class: Yeah.	Mrs. Grey verified the student's ideas. Then Mrs. Grey led the student to reflect on whether his answer was useful.
Mrs. Grey: When I did that (Mrs. G writes 1,700 ÷ 3), I would still say (Mrs. G writes 1700 ÷ 3 estimated to 600). Do you like that better? Whole Class: Yes.	
Mrs. Grey: So Lucy (non-EBs, a pseudonym), if that is the case, does 490 check out? Whole Class: No	Mrs. Grey invited another student Lucy to join the conversation.
Mrs. Grey: (Mrs. G writes 490 × 35 = 1,715.0) Could I do this (Mrs. G writes 4 × 5 = 2.000) to save myself time? Whole Class: Yes.	Then Mrs. Grey guided students' reasoning from a "time-saving" perspective.
Mrs. Grey: I heard someone say yes, explain why that saves my time to know 490 is the correct answer, Lucy. Lucy: Because it was close. It is the closer, the better, 1,700.	Mrs. Grey asked Lucy to explain her ideas.
Mrs. Grey: We knew that 49 times 35 was 1,715. So we're not distributing what our numbers are, it is the magnitude of our numbers, how large the number is with the power of 10, and how small it is with the power of 10. Alright, how about number 6?	
Videotaped on March 7, 2019	

Kevin's responses and asked the entire class to reflect on whether Kevin's idea would help find the answer. When Lucy expressed agreement, Mrs. Grey promptly invited her to elaborate on her ideas to delve into Lucy's thinking.

Overall, in the above assessment conversation, Mrs. Grey created multiple opportunities to invite students to contribute to the class discussions. She foregrounded students' ideas and used higher cognitive demand questions when eliciting students' thinking. According to Mrs. Grey, using probing questions is a good way to support students' engagement and participation. She stated,

> *I think the key to a strong lesson and student engagement is knowing what questions to ask them so that you do not give them the answer.....a lot of the practices that you see in my classroom have developed into being very strong because of that work, the ideas that you can ask probing questions of students, not leading questions but probing questions, to get them to connect what they need to connect to be successful with math. [Informal Interview on February 22, 2019]*

Lower-Level Practices of Funneling Questioning in Eliciting Student Thinking.

In the lower level of funneling questioning practices, Mrs. Grey tended to ask students lower cognitive demand questions such as factual questions. Usually, general evaluative feedback was presented to students to progress them toward the right answer. Students did not seem to have enough opportunities to express their thinking. Table 8 shows an example of Mrs. Grey's lower-level funneling questioning practice. During the conversation, Mrs. Grey walked students

Table 8.
What Goes into My Thinking Bubble?

Transcripts	Comments
Mrs. Grey: What goes into my thinking bubble, Tasnime? (Students and Mrs. G were working together to look for the answer to the math problem of 1,533 ÷ 21.) Tasnime: 20. Mrs. Grey: 20, great job. So I am thinking 20, that is super close, right? Tasnime: Yeah.	Mrs. Grey initiated a factual question. Then Mrs. G provided general positive feedback.
Mrs. Grey: And 15 is too small for 21, so this is (Mrs. G circled 153, the dividend is 1,533) what we are looking at. We are looking for a three-digit subtraction problem, right? Tasnime, how many twos in 15? (Wait for Tasnime's response). Tasnime: 6.	Mrs. Grey explained the procedure, followed by another factual question.
Mrs. Grey: Oh, that is 12. Can we get another one? Tasnime: 7.	Instead of pointing out that her answer was wrong, Mrs. Grey guided the student to give another answer.
Mrs. Grey: 7, right? So we do 21 times 7, which is 147. Do you think that is close enough? Tasnime: Yeah.	Mrs. Grey revoiced the student's response and led Tasnime to reflect on her answer.
Mrs. Grey: But that is 7, right? We need to scale up by 10 (Mrs. G added a 0 behind 147). Would we have 70 up here (the quotient place)? Does that look good? Then we are going to subtract, 13 minus 7? Tasnime: 6.	Mrs. Grey explained why they were doing subtraction at this moment, with a follow-up factual question.
Mrs. Grey: Thank you. Now Moiz, what is next? Moiz: Ah, 21 times 3. Mrs. Grey: Oh, tell me how you got that, Moiz? Moiz: Yeah. 3 times 1 equals 3; 3 times 2 equals 6 (doing the multiplication of 21 times 3).	Mrs. Grey invited Moiz to participate in the conversation. Then Mrs. Grey asked Moiz how he got his answer.
Mrs. Grey: Awesome. Moiz, can I use my estimation skills too? How many 2s in 6? Moiz: 3. Mrs. Grey: 3, Awesome. So that is 3 [added 3 at the quotient place]. So what is our quotient, Moiz? Moiz: 73. Mrs. Grey: So smart.	Mrs. Grey asked a factual question about the quotient. Then Mrs. Grey offered evaluative feedback that was not relevant to the math task.
Videotaped on March 5, 2019	

through solving a division task (i.e., 1,533 ÷ 21) to obtain the desired answer.

In this dialogue, Mrs. Grey constantly took the role of "leading" the discussion rather than "facilitating" the discussion when she interacted with students. Limited opportunities were provided to the students such as Moiz to express their thinking. In this case, the teacher's questioning practices are considered to be at a lower level.

Discussion

Responsive teaching demands teachers to maximize students' learning opportunities. An essential aspect of this approach is emphasizing the significance of students' motivation and involvement in both teaching and assessment (Alic et al., 2022; Andrews & Bandemer, 2018; Herbel-Eisenmann & Breyfogle, 2005; Leenknecht et al., 2021). Regarding the teacher-student interactions during informal FA, findings in the study shed light on the importance of teachers foregrounding students' ideas. The study's findings on emphasizing students' ideas are aligned with the FA underlying theory of students constructing knowledge through social interactions (Black & William, 1998a; Pryor & Crossouard, 2008; Janeth, 2019). As Mrs. Grey mentioned, students were more at ease engaging in assessment discussions and expressing their thoughts when they perceived that teachers valued their input.

Findings in the study also provide insights into how teachers support students to internalize learning targets. Previous studies have addressed the importance of clarifying learning targets in FA (e.g., Moss et al., 2011). Unfortunately, there have not been many studies that thoroughly examine how teachers communicate learning targets with students. In this study, Mrs. Grey valued students' ideas and supported students' internalization of learning targets from three perspectives: (1) bringing students' prior ideas to the current assessment conversation, (2) revisiting learning targets at the end of a lesson, and (3) discussing the ownership of learning with students during the assessment conversation. Mrs. Grey's approach in communicating learning targets with students can contribute to the existing research on the use of FA.

In addition, Mrs. Grey's instructional methods provide valuable insights into the effective utilization of questioning practices to elicit students' thinking. According to Mrs. Grey, in the realm of assessment conversations, employing probing questions such as "how" and "why" can effectively facilitate students' engagement and participation. Mrs. Grey's comment aligns with the current research work by Park and colleagues (2020), which emphasizes the importance of utilizing open-ended follow-up questions. Moreover, Mrs. Grey's questioning practices illuminated the importance of involving students by listening to students' responses and asking follow-up questions based on students' ideas. A funneling questioning pattern was found in Mrs. Grey's informal FA practices when eliciting students' thinking. Compared with the traditional IRE pattern, funneling questioning provides a better space for students to explain and justify thinking (Herbel-Eisenmann & Breyfogle, 2005). Yet, there is still room for Mrs. Grey to improve her FA practices. To better elicit students' thinking, the study suggests that Mrs. Grey level up her questioning practices and bring more practice of focusing questioning to her classrooms. This is because funneling questioning can still limit opportunities for students to make contributions to the assessment conversations since "it directs their thinking in a predetermined path based only on how the teacher would have solved the problem" (Herbel-Eisenmann & Breyfogle, 2005, p.486). The utilization of the focusing questioning contributed to students' learning outcomes and confidence (Alic et al., 2022; Hagenah et al., 2018). To enact the focusing questioning, it requires teachers not to rush to get desired answers but to listen to students' responses and give students enough space to justify their thinking (Herbel-Eisenmann & Breyfogle, 2005; Andrews & Bandemer, 2018). Meanwhile, teachers need to understand the conceptions and misconceptions that students may have, plan tasks, and develop purposeful questions (Andrews & Bandemer, 2018).

In terms of the overall enactment of FA, Mrs. Grey's informal FA practices showed a consistent pattern in the following two aspects: (a) using math tasks to elicit students' learning evidence, and (b) creating a collaborative culture of learning. However, there seemed a larger variation in Mrs. Grey's practices of communicating learning targets compared to her practices in gathering students' learning evidence. The study is not alone in showing teachers' uneven and incoherent implementation of FA practices. Polly and colleagues (2016) found teachers struggled with aligning their FA practices with the mathematics standards and using the assessment data to inform instructions. The uneven implementation of the different stages of FA calls for further discussions on teachers' FA professional development. Mrs. Grey reported that her practices of communicating learning targets were influenced by her instructional time. To gain a better understanding of FA implementation, it is crucial to systematically examine the factors that may influence teachers' decision-making regarding when and how to choose to communicate learning targets with students.

Conclusion and Implications

This study examines how an elementary teacher tried to prioritize students' ideas using an exploratory case study approach. It provides insights into how the

teacher employed informal FA, specifically looking at the teacher-student interactions. During the study, it was observed that Mrs. Grey tended to use funneling questioning when eliciting students' thinking. Though not intending to generalize the study's findings, it is crucial to conduct further empirical research to explore how elementary teachers implement questioning techniques to elicit students' thinking during FA. Given the benefits of using focusing questioning, the study recommends that teachers bring more focusing questioning practices in order to provide students with more meaningful assessment experiences. In addition, it is suggested that teachers conduct action research to reflect on their beliefs concerning the preparation for meaningful assessment conversations in math classrooms. This includes planning math tasks and the development of questions that prioritize students' thinking (Andrews & Bandemer, 2018).

Another essential feature of high-quality FA is the use of self and peer assessment, including peer feedback, to foreground students' participation (Black & William, 1998a; Black & Harrison, 2001; Leenknecht et al., 2021; Wylie & Lyon, 2016). Research has shown that student-initiated self-assessment enhanced the effectiveness of FA (Lee et al., 2020). Yet, elementary teachers had difficulty in incorporating self and peer assessment, partly due to their concerns about the objectivity and reliability of these assessments. (Volante & Beckett, 2011). With a focus on the whole class discussions, this study did not show clear evidence of the teacher using self and peer assessment while enacting the informal FA. As such, one potential limitation of the study is that it lacks a self-assessment and peer assessment component when examining the teacher's FA practices. Furthermore, the findings of this study may only represent a portion of the teacher's teaching practices since I observed only one math unit in the participating teacher's class. As the topic of the math content can influence a teacher's practices, the study proposes that future research including a longer classroom observation, such as an entire academic semester, to gain a more comprehensive understanding of how teachers implement FA.

Footnotes

[1] I used "whole class" instead of specific student name in the transcripts when most students in the math class responded to Mrs. Greys questions together.

[2] All students' names used in the tables are pseudonyms.

[3] < > refers to a missing word or phrase that could not be identified.

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