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Teaching Approaches of Community College Mathematics Faculty: Do They Relate to Classroom Practices?

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We report on a qualitative investigation of the ways in which 14 faculty members in the mathematics department at a community college described their approaches to teaching and contrasted those with analyses of their mathematics lessons. We characterized instructors' teaching approaches as traditional, meaning-making, or student-support and classified framing talk and mathematical questioning in the classroom. We found an association between instructors' descriptions of their approaches to teaching and their enactment in the classroom through framing talk but no association between these approaches and instructors' use of novel mathematical questions. Categorizations of teaching approaches that include classroom data to describe the interactions between students, content, and instruction can provide actionable information to influence teaching practice in higher education.

KEYWORDS: teaching approaches, framing talk, questioning practices, mathematics, community colleges

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Community colleges educate about 50% of all undergraduates in the United States (Dowd et al., 2006) and nearly 50% of all undergraduate mathematics students (Rodi, 2007). Despite this, surprisingly little research exists on the quality of community college mathematics instruction, a critical element that can contribute to students' further academic success. In spite of the mounting evidence about the low passing rates and costs associated with mathematics courses (particularly in remediation), classroom instruction—what teachers do in the classroom with students and with content—has been left unexamined. Investigations on teaching in higher education have attended to general aspects of classroom teaching and produced classifications of "teaching approaches" using mostly interviews with instructors or students' surveys. In this article, we sought to investigate how community college instructors' descriptions of their teaching approaches during interviews manifested when they were teaching a mathematics course via the framing talk and mathematical questioning used. The data, from 14 faculty members who were teaching courses from remedial mathematics to pre-calculus at a community college, include structured interviews and class observations.

This is foremost an investigation of instruction situated in mathematics classrooms at community colleges. Interestingly, and as we elaborate in the literature review section, we have found a lack of agreement among scholars in higher education in the terms used to talk about teaching. Not only have some labels like *teaching conceptions, teaching styles, teaching orientations*, and *teaching approaches* not been defined, they leave out the interactions occurring between students and teachers with content. Most studies on teaching look at methodologically elusive aspects of the interaction (e.g., approachability, clarity, style, organization, and flexibility). Adding to this cacophony of terms, the higher education literature also refers to "teacher-centered," "content-centered," and "student-centered" approaches. *Teacher-centered* and *content-centered* approaches are used interchangeably to refer to situations in which the teacher delivers content to students who are seen as "passive" spectators; students sit in the classroom, take notes, and interact with the teacher only as requested, via answering or asking questions. These two approaches are usually presented in opposition to "student-centered" approaches, which are used to describe situations in which the students work "actively" in groups during class, answer questions for which they have to reflect and share answers with a partner, or solve problems for which no solution is known (as in problem- or inquiry-based learning). This literature has advanced the idea that student-centered approaches can be more effective than teacher-centered or content-centered approaches in terms of student learning (Barr & Tagg, 1995), yet the empirical support for the claim is limited; in fact, establishing the effects of teaching on student learning is an open-ended question not only in mathematics, but in the field of education (Hiebert & Grouws, 2006). Thus, there is a need for a definition of instruction that can be operationalized in ways that allows for investigations of the role of different teaching approaches in providing students with opportunities to engage with subject-specific content in the classroom.

We chose to situate the investigation in mathematics instruction at community colleges for three reasons. First, substantial work has been done in mathematics education on instruction, thus providing a good starting point for our investigation. Second, in the most recent report from the College Board of Mathematical Sciences (Blair, Kirkman, Maxwell, 2013), over 2 million students were taking a mathematics course in a community college in the year 2010. And last but not least, the controversies surrounding the value and cost of remediation (Attewell, Lavin, Domina, & Levey, 2006; Bailey, 2009; Melguizo, Hagedorn, & Cypers, 2008) affect community colleges more directly given that they deal with nearly 83% of all mathematics remediation (Lutzer, Rodi, Kirkman, & Maxwell, 2007).

The community college setting offers three other features that add to the relevance of this investigation. Community colleges are recognized as "teaching" institutions, and thus they provide an ideal space to investigate instruction. Second, being open access institutions, community colleges bring together a diverse group of students and teachers that can make instruction more complex than in a more selective setting. Third, there is a clear shift in the discourse around community colleges from access to student success that has increased pressures on the colleges (Baldwin, 2012). While there is literature that has identified students' and institutions' characteristics related to retention and success (Bahr, 2010; Pascarella, Wolniak, Pierson, & Terenzini, 2003), there is little research on the factors associated with mathematical instruction that can be directly related to retention and success in community colleges.[1]

Literature Review

Teaching is a complex endeavor. Using different lenses to the analysis of instruction at community colleges has brought to the fore the differences in conceptualization of teaching used by scholars in two different fields, higher education and mathematics education. The literature in higher education has developed constructs such as "teaching conceptions" and "teaching approaches" to categorize the variation in teaching across disciplines and across colleges and universities. In contrast, the literature in mathematics education has attended more closely to the interaction between students and instructors with specific mathematical content to describe behaviors in classrooms that determine how students, instructors, and mathematical content interact day to day.

Studies of Instruction in Higher Education

Independent studies of teaching in higher education conducted in different countries have arrived at comparable constructs using different terminology. The most general concept used by researchers is *teaching conceptions*, defined as the set of instructors' beliefs and values toward teaching (Kember, 1997; Prosser & Trigwell, 1999). When describing specific strategies, methodologies, and instructional activities, some scholars use *teaching approaches* (Gregory & Jones, 2009; Grubb, 1999). Main critiques of these studies point out methodological weaknesses: relying on inventories and questionnaires, sample-biased interviews, and an inconsistent use of categories such as beliefs, conceptions, approaches, and orientations, which makes it difficult to use them to describe teaching (Ashwin, 2009; Kane, Sandretto, & Heath, 2002; Meyer & Eley, 2006). In addition, there is limited efforts to establish consistency between what is said (in interviews) and what is done (in the classroom), something that has been routinely done in K–12 education (e.g., Cohen, 1990; Romagnano, 1994).

Most of the characterizations of teaching approaches suggest a hierarchy that implies that student-centered approaches are more effective than teacher- or content-centered approaches (Åkerlind, 2003; Kember & Gow, 1994; Prosser & Trigwell, 1999). This hierarchy is rooted in Marton and Säljö's (1976) study on students' learning, which claims that a student-centered approach is more effective because it promotes "deep" rather than "surface" learning processes. Kember, Kwan, and Ledesma (2001) also found that in contrast to "content-centered" instructors, "student-centered" instructors can identify different needs and experiences among their students and adapt their teaching accordingly, thus implying that "student-centered" approaches are better for the students. Yet the connection to students' learning is rather tenuous.

Classifying instructors and their goals as being in one place or the other has been empirically complicated. Kember and Kwan (2000) found that no instructor could be characterized as belonging to only one of categories they proposed. Some scholars suggest that a teaching approach that fits students' learning styles is more effective (Felder & Silverman, 1988), although the empirical evidence for this claim is limited (Pashler, McDaniel, Rohrer, & Bjork, 2009). Other studies have focused on the teaching techniques that elicit student participation (Auster & MacRone, 1994; Nunn, 1996). For instance, Nunn (1996) found that teacher questions, praising students, and using their names and ideas were positively correlated with student participation in the classroom.

In summary, most of the studies in higher education advocate more use of student-centered approaches, arguing that they help students better, regardless of disciplinary differences. However, there are strong criticisms about the methods used in pursuing these investigations, and there appears to be limited empirical evidence about the impact of student-centered approaches on students' learning.

Studies of Instruction in Mathematics Education

In contrast, there is substantial research on instruction in the mathematics education literature. These investigations assume that social interactions are crucial for learning and recognize that teaching and learning are both individual and social processes (Cobb & Yackel, 1996; Sfard, 2001; Yackel & Cobb, 1996). These investigations follow closely what is done and said in the classrooms, providing detailed analyses of students' and instructors' discourse, with the ultimate goal of describing the quality of teaching and learning that happens with a specific mathematical task in a particular context (Moschkovich, 2008; Stein, Lane, & Silver, 1996). These studies have highlighted the role of two elements, the teachers' way of communicating in the classroom and the quality of mathematics. The way teachers talk in the classroom can open up or close down student participation (Mesa & Chang, 2010). The classroom environment can create a sense of belonging (e.g., when teachers use students' names or when they tell anecdotes about their own math teachers) in which students feel comfortable and safe in sharing their thinking and emotions (Boaler, Wiliam, & Zevenbergen, 2000; Stipek et al., 1998). On the other hand, the classroom environment can distance students from the subject: Teachers' talk can socialize students to view mathematics as a collection of disconnected facts and arbitrary laws, produced in isolation, with limited applicability to real situations and to view themselves as receivers, not creators of mathematics (Mesa & Chang, 2010; Schoenfeld, 1988). Proposals for reforming K–12 mathematics have advocated for students and teachers to counter this view, so students and teachers are able to view mathematics as a connected set of ideas and skills that is a collectively generated body of knowledge and a powerful tool to understand the world (National Council of Teachers of Mathematics, 2000). This is to be accomplished by using teaching strategies that encourage students to explain their thinking and to take an active role in constructing their mathematical understanding. Thus, attention to the way in which teachers talk in the classroom is an important element that can contribute to an understanding of how mathematics is taught and learned.

When attending to what teachers say and do in the classroom, the quality of the mathematics becomes crucial. This quality can be assessed via the complexity of the tasks used and the nature of the questions asked. These determine the opportunities for students to engage in authentic mathematical activity (Ball & Bass, 2000; Henningsen & Stein, 1997). Questions that invite students to state conjectures, propose alternative solutions, investigate mathematical reasons, and justify their own thinking are in general associated with high cognitive work and are preferred over questions that ask students to repeat known facts or to practice a procedure (Stein, Smith, Henningsen, & Silver, 2000). These questions, also called novel or authentic (Mesa & Lande, in press; Truxaw & DeFranco, 2008), play a significant role in shaping the opportunities that students have to learn authentic mathematics in the classroom.

In summary, research in mathematics education highlights the importance of looking at how the interaction between students, teachers, and the content shapes students' views of mathematics and their opportunity to engage with the content.

Research Questions

Bridging the higher education and mathematics education traditions to the study of instruction can shed light on the relationship between how instructors describe their practice and how they enact such practice in their mathematics classrooms. In order to be able to bridge these traditions, however, it is important to sort out the differences in terminology before empirically corroborating claims advanced by the literature. Toward these ends, we propose definitions of two critical notions, *instruction* and *teaching approaches*, and offer a different interpretation for the terms *teacher-centered, content-centered*, and *student-centered* approaches, which we will use in the remainder of this article.

Studying mathematics instruction requires one to see not only what teachers "do, say, or think, with learners concerning content in particular organizations and other environments in time" (Cohen, Raudenbush, & Ball, 2003, p. 124) but also what happens in the classroom when teachers interact with students *and* the mathematical content, *and* how that interaction might be influenced by specific classroom and institutional environments. This definition of instruction allows us to determine where the instruction is "centered" and to zoom in on the classroom to study the interactions in the context in which they occur.

We refer to teaching approaches as actions and strategies described and enacted *by instructors* when they talk about teaching mathematics or when they actually teach mathematics. We see the instructor as the ultimate orchestrator of the activity of instruction in any given lesson: It is the instructor who selects the content, the activities, and the sequencing of topics; he or she decides when to ask questions or when to organize students to work in groups, and so on. Thus, the teacher has a crucial role to play and therefore we see all instruction as teacher-centered. For us, there is no need to pit the teacher against the students as when the terms *teacher-centered* and *student-centered* are used. A more adequate distinction of approaches can be made depending on what instructors appear to privilege during the interaction—the students or the content.

We call *student-centered* approaches those instructor descriptions and strategies that appear to be driven by instructors' interest in attending to students' cognitive, social, and emotional needs, seeking to give students a more prominent role in classroom activities. We call *content-centered* approaches those instructor descriptions and strategies driven by instructors' interest in emphasizing the content over students' cognitive, social, or emotional needs and involvement.

Because the literature in general favors student-centered approaches over content-centered approaches, we anticipated instructors would frequently describe approaches that are student-centered during their interviews and sought to determine whether instructors' actions in the classroom aligned with features of either a student-centered or a content-centered approach. Given the importance of questions in generating opportunities for students to learn mathematics, and the literature's preference for student-centered approaches, we wanted to see whether teachers who more frequently described student-centered approaches were more likely to use more challenging questions in their teaching than teachers more frequently describing content-centered approaches. The specific research questions for our study were:

Research Question 1: What is the relationship between the teaching approaches that instructors espouse during interviews and the teaching approaches that they enact in their classrooms?

Research Question 2: What is the relationship between the use of novel questions and instructors' description and use of teaching approaches?

Methods

Setting

The setting for this study is a large suburban community college in the Midwestern United States with two small satellite campuses, an approximate enrollment of 12,000 students, and an average retention rate of 50%. At the time of the study, yearly retention rates for first-time, bachelor's degree–seeking undergraduates were 65% for full-time students and 45% for part-time students. The overall graduation rate within 150% of normal time to program completion for first-time, full-time, degree- or certification-seeking students was 13%. The average age of the students in the college was 33 years (29 for credit students and 45 for non-credit students). Ages ranged from 16 to 90, and the modal age was 19. The minority population was about 28%. Females comprised 56% of the total enrollment. About 70% of students were residents in the county and 5% were out-of-state or international students. Nearly 40% received financial aid and 32% were Pell grant recipients.

The mathematics department has 17 full-time and about 75 part-time instructors and offers an average of 22 different courses per term, including remedial math (e.g., fundamental math, beginning and intermediate algebra); science, technology, engineering, and mathematics (STEM) preparatory courses (college algebra, college trigonometry, and pre-calculus); and college-level mathematics courses for professional and STEM degrees. This particular college was chosen because the students' rating of teaching in the mathematics department was high (above 4.2 on a scale from 1 to 5), suggesting high student satisfaction with teaching. In addition, the department had recently appointed a very dynamic department chair, committed to investing time to improve teaching. Moreover, like other colleges in the state, the faculty felt pressure to increase passing rates in their courses and had received substantial support from the administration to engage in activities that would result in better passing rates (e.g., time release for a faculty development group, periodic evaluation of curricula and syllabi, or coordinating part-time instructors).

Data Collection

The primary sources of data come from in-depth interviews with 14 instructors and observations of their teaching (72 lessons) collected over a 2½-year period (fall 2007–fall 2009). In the first phase of data collection (fall 2007–winter 2008), instructors were selected from a list provided by the chair that included "good" teachers: Their sections filled up first and their end-of-course student evaluation scores and passing rates were above the average in the department. Ten instructors were invited to participate in the study and 7 accepted. In the second phase (fall 2008–fall 2009), all 12 instructors teaching a STEM preparatory course (college algebra, trigonometry, or pre-calculus) were invited to participate. Eight of them accepted the invitation, including 1 instructor, Emmett, who participated in the first year, yielding a sample of 14 instructors. Except for 1 instructor, who was new to the school, all the instructors were recognized as "good" teachers. We sought to represent in the sample the type of course taught (remedial or nonremedial), faculty's employment status (part- or full-time), gender, and years of experience (minimum = 2 years, maximum = 28, average = 11 years, *SD* = 8.48). These two phases of recruitment yielded a balanced representation of college preparatory courses that help students get ready for a wide range of careers in both STEM and non-STEM fields (see Table 1).

The interviews with the instructors covered seven areas: their academic and teaching background, their teaching practices, their conceptions and philosophies of teaching, their perceptions of students, and their perceived personal, collegial, and institutional influences on teaching.[2] These were structured interviews that lasted between 45 minutes and 2 hours. We also collected details about the classes we would be observing. At least three full lessons per instructor were observed in order to characterize students' participation patterns and the nature of questions asked. If an instructor participating in the second year was teaching more than one section of a STEM preparatory course, each section was also observed three times. This

Table 1
Characteristics of Instructors in the Study

Name	Years Teaching Experience	Degree	Year Observed	Course Observed
Earl	13	MA, math education, psychology	2	College algebra (2)
Edward[a]	3	BS, math	2	Trigonometry
Edwina[a]	28	BS, math education	2	Trigonometry
Elena	20	MA, math education	1	College math, foundational math
Elijah[a]	7	BS, engineering	1	Intermediate algebra, math analysis
Elizabeth	7	MA, math	2	Pre-calculus (2), trigonometry
Elliot[a]	6	BS, economics	2	Trigonometry
Elrod[a]	2	PhD, ed. psych	1	Statistics
Emily[a]	2	BS, math	1	Arithmetic
Emmett	16	PhD, physics	1, 2	Intermediate algebra, trigonometry (3)
Erik[a]	2	BA, math education	1	Arithmetic, beginning algebra
Erin	19	MA, math education	1	Arithmetic, intermediate algebra
Ernest[a]	21	BS, math education	2	Trigonometry
Evan[a]	8	BS, physics, math	2	Trigonometry

Note. Names are pseudonyms. Numbers in parentheses indicate the number of different sections observed.
[a]Part-time instructor.

resulted in the observation of nine different courses and 24 different sections (for a total of 72 classroom observations, average length of instruction per instructor was 79 minutes, minimum = 40 minutes, maximum = 116 minutes). The lessons were audio-taped and extensive field notes were taken. All audio recordings were transcribed verbatim.

Analytical Frameworks

We used analytic frameworks already existing in the literature to describe the nature of instructors' teaching approaches. One framework was derived from the higher education literature by combining two different perspectives that showed great potential to analyze both what teachers said about teaching during interviews and what they did while teaching. The second framework was derived from the mathematics education literature and was used to analyze mathematical questions. The frameworks were developed independently of each other.

Teaching Approaches Framework for Interviews

The development of the analytical framework used for coding the instructor interviews was based on the work by Grubb and Associates (1999), who proposed three teaching approaches: *traditional, meaning-making*, and *student-support*. According to Grubb, teachers using mainly a traditional approach prioritize content transmission and use mostly lecturing. They place themselves as the authority in the classroom and emphasize covering the content and the importance of examinations. Teachers utilizing a meaning-making approach prioritize students' learning and use activities that encourage students' participation in the classroom as these activities make students' thinking about the content more visible. Finally, teachers using mainly a student-support approach prioritize students' needs (e.g., increasing their self-confidence) by, for example, making concessions about curriculum coverage or deadlines for assignments. They are highly empathetic to students' life circumstances; for them, learning the content is secondary to students' well-being in general. Using our definition of content-centered and student-centered approaches, we consider Grubb's traditional approach content-centered and meaning-making and student-support approaches student-centered.[3]

The development and refinement of this framework was done in three stages. First, the second author coded two interviews to produce a first version of the coding system. Using this system, the first and second authors independently coded a new transcript of another instructor and met to compare the coding and discuss discrepancies. Each coder identified 25 passages for coding[4] but found agreement on the coding of only 16: The coders identified the same passages and the same categories but differed in the reasons for inclusion in a given category. These discrepancies were resolved through discussion, and the definitions of all the categories were refined. In the last stage they separately coded a new transcript. This time they identified the same number of passages, 25, agreeing on 23 of them. The coding of these four transcripts showed different emphasis among instructors, consistent with the first author's impressions during interviews. This increment in interrater agreement and the face validity of the coding gave us confidence that the system could be applied reliably to the rest of the interviews. The final definitions for these categories are given in Table 2, together with sample excerpts from the interview transcripts. As is apparent from the examples, teachers described their teaching in ways that fit several of the categories in our framework. We coded on average 34 passages per transcript (minimum = 21, maximum = 52). We then calculated the percentage of codes assigned to each interview that fell into each of the three categories.

Framing Talk Framework

We used Gregory and Jones's (2009) operationalization of teaching approaches as a starting point to categorize general strategies teachers use

Table 2

Teaching Approaches Framework

	Framework Categories	Definition of Categories	Examples
Content-centered approach	Traditional	Instructors using this approach privilege knowledge transmission and covering the content that has been structured to fit in a certain period of time. Instructors may or may not take into account students' needs related to content or their different learning approaches for organizing their lessons	*Covering the material fast*. Because this is content heavy class so I don't want to get bogged down by, I need to be able to move quickly in this class and so I need to make sure that they have everything. So this way I know that they've gotten it all, . . . because it's fast. I mean this is one of those classes you go fast, you do the whole book and it has a very broad spectrum. (Elizabeth, p. 3) *Reading the body language*. I also . . . try to gauge body language, facial expression of course. It's pretty easy to tell when they're lost. (Elizabeth, pp. 1–2)
Student-centered approaches	Meaning-making	Instructors using this approach act as learning facilitators and encourage students' participation. They may modify the class structure to accommodate students' needs by either making expectations and demands from students explicit or by developing relationships among students and between students and the instructor.	*Discussing and guiding*. On my projects I often ask them, . . . after they've done some number crunching, to write for me what their, what their outcome was, what they found, like on that survivor project they had to write, I gave them . . . many lines and told them to write it out, tell me, not just in a sentence but clarify it for someone who . . . is going to be reading this, whether or not these people are going to survive, why or why not. (Erik, p. 4) *Coaching role*. To motivate them to learn or to come . . . I try and make it so that they want to come. I try and acknowledge reasons why they wouldn't and that I understand why you wouldn't want to do this or participate in this or come to this or whatever, but I believe, I kind of put myself, not so much an authority role as like a coaching role. (Elizabeth, p. 2)

(continued)

Table 2 **(continued)**

Framework Categories	Definition of Categories	Examples
Student-support	Instructors using this approach encourage students and boost their self-confidence. Although important, they may place less emphasis on learning the content. They may direct students to use resources available for them in the institution without adapting the pre-established structures of their classes to fit students' needs or they may take into account students' needs by developing relationships among students and between students and the instructor.	*Resourcing*. We have two different places where students can go to get free tutoring, which is just amazing. . . . I have a lot of single mothers in my classes and you know we have a day care facility on campus. . . . We want to see them succeed [tell those who] wanted to be a nurse when they were 12 or 14 they can still do that, that their decisions affected their lives but they weren't, they didn't permanently doom them. (Erik, p. 6) *Adapting testing to reduce anxiety*. I'm doing weekly quizzes because they get very stressed out at tests. . . . So then at the end of the class it would be a quiz and that might take some people 15 minutes, that might take some people half an hour, I try to budget about half an hour. So then . . . I can walk around and reassure and even help a little bit, even though I call it a quiz I might say "Oh don't forget you have to reduce that fraction" or "Do you know which type of problem this is?" And just to lower that anxiety level and [it's] not everybody's sitting in the room, it's only the people who are left so they don't feel as uncomfortable with me doing that. (Elena, p. 2)

as they talk to engage students with the content, create a classroom climate that is conducive to learning, and maintain students' attention during lessons. We call these strategies *framing talk*. Using grounded theory with interviews and classroom observations at Australian universities, Gregory and Jones proposed a model generated by the intersection of two continua, focus on ideas or on people and structured or flexible. The first continuum is akin to the dichotomy between content- and student-centered approaches found in the literature, while the second introduces a new dimension that describes instructors' willingness to adapt the structure of their lessons to students' needs.

Gregory and Jones's (2009) description of teaching practices provided us with a list of strategies that we used to code the framing talk in our classroom transcripts. For example, these authors interpreted instances when instructors were "providing cues," "assessing," "maintaining standards," "questioning text," "establishing rules," and "monitoring time" as strategies used by instructors who focus on ideas rather than on people and exhibit a structured classroom style (p. 776). We followed a constant comparative method with different classroom transcripts, which the first two authors coded independently, meeting regularly after coding a transcript to discuss alignment and new categories.[5] After the first coding, we found agreement in all the selections and in the code assignment, but added two more strategies: "using personal stories" and "reading nonverbal cues." Through this iterative process with three different transcripts we refined the strategy list until we obtained an exhaustive list of 30 different strategies that teachers used during framing talk (see Table 3). Once we reached saturation in the coding system (no new codes and 100% agreement in the codification), the second author coded all the remaining transcripts. We verified the coding during weekly meetings and discussed cases in which the coding was not straightforward (about 5% of the total coding). We assigned a total of 401 codes (average per instructor was 31, minimum = 7, maximum = 64). The codes were mutually exclusive. Rather than seeking to establish how long instructors used a particular strategy, we assessed whether a given strategy was used at all and how many times it was used. We excluded Edwina's classroom transcripts from this analysis because her transcripts were too short (students worked individually on their homework for nearly two-thirds of the class time) and generated very few codes, which did not give us confidence that we were appropriately characterizing this aspect of her teaching.

A last step consisted in grouping these strategies into one of the three main categories, traditional, meaning-making, and student-support. The strategies that we grouped as fitting a traditional approach were those that stressed the instructor's authority and expertise, the importance of doing homework and taking examinations, and the use of textbook, calculators, and online resources. Strategies classified as meaning-making reflect the need to make connections between mathematics content and real contexts

Table 3
Codes for Framing Talk Strategies

Traditional	Meaning-Making	Student-Support
1. Assigning homework	1. Assigning individual work during class	1. Being available
2. Being inflexible with content	2. Being flexible with content	2. Being flexible with requirements
3. Controlling time	3. Checking conversations	3. Knowing names
4. Covering the material	4. Making connections to real context	4. Praising
5. Doing it in this way	5. Noticing nonverbal cues	5. Showing empathy for students' life circumstances
6. Following the book	6. Receiving formal feedback	6. Starting informal conversations
7. Giving extra credit	7. Recognizing self-limitations	7. Using humor[a]
8. Making explicit credential-skills-knowledge	8. Asking students to go to the blackboard	8. Using personal stories
9. Making references to advanced courses	9. Making suggestions about how to work	
10. Mentioning access to online resources (text and homework)		
11. Setting expectations		
12. Talking about examinations		
13. Using calculator		
14. Using humor[a]		

[a]"Using humor" was classified into either traditional or student-support according to the context. If using humor was used as a strategy to produce a short break in the presentation or if it made reference to the content, it was classified as traditional. On the other hand, if using humor was used to create a more personal or close relationship with the students, it was classified as student-support.

and instructors' efforts for appearing as a guide rather than an expert. Finally, framing talk strategies grouped in the student-support category conveyed a more direct and informal relationship with students, interest in providing emotional support, and instructors' flexibility with requirements to adapt to student circumstances. Table 3 lists the strategies and how they were grouped into the three main categories.

For each teacher, we calculated the frequency of codes within each category and created a proportion relative to the total number of codes assigned in a transcript for each instructor.

Mathematics Questions Framework

We developed this analytical framework by drawing from work that analyzes questions in classrooms (Nystrand, Wu, Gamoran, Zeiser, & Long, 2003; Wells & Arauz, 2006), specifically questions in mathematics (Nathan & Kim, 2009; Truxaw & DeFranco, 2008), and by using the data we collected. We synthesized various features of these frameworks and produced a categorization of questions attending to the authenticity or novelty of mathematical questions (Nathan & Kim, 2009; Truxaw & DeFranco, 2008) and tasks (Doyle, 1988; Herbst, 2003). We took each teacher question that was mathematically oriented and determined whether the question was *routine* or *novel*. We define questions as routine when students are expected to know the answer or to know how to procedurally figure out the answer using information given in the class or in previous classes or courses. We define questions as novel when the answer or the procedure needed to answer it is not known (e.g., students are required to explain new and old connections between mathematical notions or to figure out something new) or to make explicit student problem-solving strategies or methods that are not routine. We made the classification taking into account the talk that preceded and followed the question (for details, see Mesa & Lande, in press).

Questions in the classroom transcripts were coded in several stages; seven coders coded one transcript independently (except for the first author, all were graduate students who were trained in the protocol). This process was used to refine definitions and agree upon decision-making strategies. Pairs of coders were assigned a new transcript and they independently coded and met to compare coding and to discuss discrepancies. These discrepancies were discussed in several weekly meetings in order to clarify and refine the definitions of the codes. Once we reached interrater agreements (Cohen's *k*) above .70 for each pair, independent coders coded the rest of the transcripts (39 lessons). The third author verified the consistency of the coding. We calculated the percentage of each type of question (novel and routine) for each teacher, using a common length of 85 minutes per class to facilitate the comparison.

Combining the Three Analyses

In order to determine how the three analyses related to each other, we defined two content-centered approach indices, one for the interview analysis and another for the framing talk analysis.[6] These indices seek to establish the extent to which an instructor tends to describe and enact instruction that is more aligned with a content-centered approach. The first index is the percentage of interview codes assigned to a traditional approach. The second index is the percentage of traditional approach strategies used during framing talk minus the percentage of meaning-making and student-support strategies used during framing talk. Thus, if during framing talk an instructor used all the 14 strategies labeled as traditional and did not use strategies labeled as either meaning-making or student-support, the index for that instructor would be 100. If on the contrary an instructor did not use any of the strategies labeled as traditional, but used all the nine and eight strategies labeled as meaning-making and student support, respectively the index for that instructor would be −200. We used these indices to test the extent to which approaches described during interviews are associated with approaches enacted in the classroom, via framing talk and the use of novel questions. We tested this association using a Spearman rho coefficient of correlation and set the level of significance of this coefficient at the $\alpha = .05$ level.

Findings

We organize our results by the three analyses we conducted and include illustrative quotes and passages from interviews and classroom observations to illustrate our findings. These analyses provide us with three different lenses that together help to characterize how these instructors teach mathematics in this community college.

Approaches to Teaching From Instructor Interviews

In our first analysis, we coded instructor interviews using the three teaching approaches framework described in the methods section. Consistent with Grubb's (1999) findings, the traditional approach is the most frequently described by our instructors, but the majority described more than one teaching approach. To facilitate the classification, we attributed a teaching approach to an instructor if the category contained 20% or more of the total number of passages coded for that instructor. So, in order to be characterized as describing a traditional approach only, instructors needed to have less than 20% of codes in each of the other two categories (see Table 4).

Traditional Approach

Instructors using the traditional approach privilege the content and the instructor's authority in the classroom. We identified 11 instructors

Table 4

Percentage of Codes for Teaching Approaches Described During Interviews and Percentage of Codes for Framing Talk From Classroom Observations, by Instructor

	Teaching Approaches, Interviews				Framing Talk, Classroom Observations			
	N of Codes	Traditional (%)	Meaning-Making (%)	Student-Support (%)	*N* of Codes	Traditional	Meaning-Making (%)	Student-Support (%)
Earl	25	48	16	36	15	67	27	7
Edward	40	58	23	21	23	57	30	13
Edwina	45	69	27	4	—	—	—	—
Elena	44	9	50	41	28	50	29	21
Elijah	31	77	13	9	27	70	7	22
Elizabeth	21	52	19	29	25	40	52	8
Elliot	33	51	42	6	14	100	0	0
Elrod	27	74	15	11	47	62	23	15
Emily	37	38	41	22	64	19	27	55
Emmett	25	84	4	12	35	60	26	14
Erik	39	10	20	70	45	22	31	47
Erin	25	0	60	40	64	22	41	38
Ernest	52	75	14	12	7	43	29	29
Evan	22	86	0	14	7	71	14	14
Total	466	51	25	23	401	53	26	22

Note. Because of rounding, percentages may not add up to 100. Edwina’s classroom transcript was not coded.

describing a traditional approach to teaching. We were able to also identify some differences within these instructors regarding the extent to which they take into account students' needs and difficulties with the mathematical content.

Instructors who more prominently described content over student needs and difficulties expected their students to learn the material on their own and preferred to cover predefined content in a set time. What matters most to these instructors is that the students receive all the content that needs to be covered, even if their students cannot keep up with the pace of the lecture. According to instructors, particularly those of college-level mathematics courses, the syllabus includes such a large number of topics that they have to go fast through all of them (e.g., "There's not a lot [of] time for extra, I don't know what to call it, for side trips." Ernest, lines 330–331).

Another characteristic of the traditional approach is the perception that the instructor is the sole authority for presenting knowledge "from a level above and articulate [it] to a level below [i.e., to the students]" (Elizabeth, lines 157–158). Students remain at a different level, a level in which mathematics is inaccessible, whereas mathematics instructors represent an elite with access to knowledge that the majority does not have: "I have two degrees in math and there's not a whole lot [at the] human level when you're learning this. I mean you're speaking in another language, it's like Latin" (Elizabeth, lines 169–171). This perception ensures the importance of the instructor in a traditional model; the instructor *must* bring mathematics down to the students' level. Students can't have direct access to new content on their own, not even with their textbooks, unless there is an instructor, a "translator" of mathematics. Instructors also report that in lower math courses the units from which students need to learn basic procedures are rigid. Earl talks about his lower division course as "factory work" where he says to his students "you learn this rule and you do it" (lines 59–60). For Earl, the "bigger picture" of math is reserved for higher courses such as calculus II.

Meaning-Making Approach

We found evidence of the meaning-making approach in the interviews with six instructors. Within this approach, the instructors seek to promote deeper learning and to connect mathematics to real-world contexts. Some of these instructors, however, make it clear that they expect their students to meet the class standards and follow the class structures while others seek to adapt their class standards or structures according to their students' needs, both cognitive and affective. Elrod, for example, asserts that understanding the purpose and meaning of statistics is what matters and that students' understanding is more important than grades on tests, because the latter focuses on computational skills:

> I'm a lot less concerned about how they do the computations even though ironically and given the institutional constraints, that's how they're graded based on, "can they compute this?" . . . I really want them to understand . . . why are they doing this, and why do people who do stats run those computations, what can you do with that? (lines 178–181)

But in spite of acknowledging that tests do not assess what is important, Elrod does not suggest alternative evaluations or activities, instead accepting that testing for skill in computation is an institutional constraint.

Being a guide or a coach, a person mediating between the students and the content, was another manifestation of instructors describing this approach (Emily, Erin, and Elliot). For instance, Elliot uses the metaphor of a football coach to illustrate his effort to generate a classroom open to questions and mistakes. This effort pays off by the students' commitment to "push themselves" to learn math:

> As far as their performance, I basically, it's almost like a football coach. You know you just you tell them you believe in them and you know what they can do and it's just a matter of you need to study this way and make sure that your thinking caps are on and I know you're going to do well. And for some reason I get the feeling that they don't want to let me down so they tend to push themselves. (lines 100–103)

A team coach can relate to his students so that they will do their best to get where the coach wants them to be. A team coach does not necessarily tune to students' needs, rather to his personal obligation to get the team to win, in this case do what the students are supposed to do ("use their thinking caps," "do well").

Affective concerns were prominent in the interviews with these instructors. Erin believes that the students' history of disengagement with mathematics and their past school experiences did not work for them. She suggests that a different type of classroom interaction might change the students' past negative encounters with the content: "They need to be involved, they need to talk about it, they need to struggle with it, they need to share their work" (lines 151–152). Another dimension of affective concerns is students' resistance. Elena said that she has to "fight" students' resistance to engage in participatory activities because students "want to be told" (line 66). This resistance is augmented when a large proportion of students in her college-level classes come from a remedial class. Elena says that in remedial classes students are "being spoon-fed" through a "lock step" system and that her task is to convince them that they can do the work on their own, without her (lines 188–189).

Student-Support Approaches

Unlike traditional and meaning-making approaches, instructors who privilege a student-support approach do not place students' mastering the content as the main goal of instruction. Rather, they focus on improving students' self-confidence and in developing relationships among students and between the students and the instructor. We identified seven instructors in this category. Like with the other categories, some instructors categorized as using a student-support approach prioritized students' needs over "covering the content," and some instructors saw mathematical structure and clear rules as crucial to improve self-confidence and address students' needs.

Instructors who taught a remedial mathematics course (Erik, Erin, Elena, and Elizabeth) tended to describe the need for improving self-confidence and developing relationships. Erik, the instructor who best demonstrates this approach, says that it is not motivation that his students lack, but confidence: "And that's when you kind of turn into a counselor more than an instructor. . . . My goal for my students, my primary goal, is to dispel the fear that they have of math" (lines 140, 271).

Different from team coaches, counselors put the individual's needs first to help him or her out. These instructors described using their personal experience to build a better relationship with their students: "If my experience coincides with my students' experience then I'll use it in class . . . my students come in with the same kind of fears I came with" (Erik, lines 31–33). These instructors also described high levels of commitment to teaching: "I get calls from my students at two in the morning . . . I work with them all the time and I'm just patient with them. I let them learn" (Erik, lines 263–265).

Not all the instructors who focus on reducing students' fear seek to build stronger personal relationship. Edward stresses the importance of "being direct and up front with students about expectations" (line 251). He sees patience and hard work as the key for students' success. His strategy consisted in clarifying standards and setting expectations early.

It is important to notice that instructors said they adapt or modify their approaches about mathematics instruction depending on the class level. For example, when Elizabeth—who displays a strong tendency toward the traditional approach—talks about her remedial courses, she abruptly shifts her descriptions toward a vision related to the student-support approach:

> [Here] the math isn't the problem. In this class you can tell them, "oh go see a tutor or meet me in my office," and mostly we can clear up most of the problems in class, I mean any questions or problems they have I'm happy to talk about with them in class. I tell them I don't want to move to the next thing until you're ready, but you have to tell me when you're ready. (lines 380–384)

Summary

Through the descriptions of their teaching, we identified three general approaches: traditional, meaning-making, and student-support, with traditional being the most commonly described by our participants. Five instructors were identified as describing mostly a traditional approach (Elijah, Elrod, Emmett, Ernest, Evan), one describing mostly a student-support approach (Erik), two describing a combination of traditional and meaning-making approaches (Edwina, Elliot), two describing traditional and student-support approaches (Earl, Elizabeth), two describing meaning-making and student-support approaches (Elena, Erin), and two describing all of the approaches (Edward, Emily). No instructor was classified as describing only a meaning-making approach to teaching. Perhaps our most important finding is that most instructors described using more than one approach (above the 20% threshold of our classification); in fact, only five described using mainly a traditional approach and only three instructors did not describe using a traditional approach. This suggests that in this context, instructors recognize the importance of being aware of students' needs, needs that are beyond learning mathematics, and that teachers, for the most part, can be flexible in how they organize their instruction depending on those needs.

Approaches to Teaching Exhibited in Framing Talk in the Classroom

In accordance with the results of the interviews, our instructors used a wide range of teaching framing talk strategies. Here we illustrate how teachers employed these strategies in the classroom, with one strategy from each teaching approach in our classification: "talking about examinations" (traditional), "connecting to real-world contexts" (meaning-making), and "knowing names" (student-support). These were the most frequently observed in the transcripts.

When talking about examinations, classified as a traditional approach strategy, instructors emphasize covering the content or bring forth concerns about making sure that the content for the course is covered. For example, Emmett said:

> If anybody takes the [departmental] exam right now you should be able to do 13 out of 15 questions. You cannot do two questions because they're from chapter eight; we haven't got to chapter eight. . . . But once we start eight next week you should be able to do the entire [departmental] exam. (lines 434–438)

In this passage, Emmett reminds the students about the departmental examination that all students must take[7] and lets them know that given what they have covered from the textbook so far, they should be relatively successful. Comments about examinations can be tied to issues of content coverage, an indication that the content is very important for the teacher.

Making statements connecting mathematics to real-world context was a meaning-making strategy used by the instructors. In doing so, they sought to create a connection for the students, mostly to increase their interest. Although the content of some courses was more likely than others to allow for these connections, most instructors used this strategy, as in this example from Edward's class, in which he invites examples of periodic occurrences in nature:

> Edward: So, what are some things, like some natural phenomena, that has sort of a periodic nature, periodic meaning, like, it repeats itself, over a, every set of amount of times? Like one example could be like . . .
>
> M: Months.
>
> Edward: Not just like, you know, sunrise/sunset. What about like waves? Waves, so look at the ebb and flow of an ocean wave, or a sound wave. Anything else? Like . . . Light,
>
> Several: [Sound]
>
> Edward: Sound. Lots of stuff. (lines 145–155)

We found great variation among instructors using their students' names in teaching, a student-support strategy. While Evan, Ernest, Elliot, and Elizabeth did not mention any student names, Erin mentioned student names 22 times. Calling students by their names might help to create a more personalized classroom and a better climate. By individualizing students, instructors might also seek student participation. For example, Emily invites students into the discussion of the problems by directly asking for help:

> Emily: Ok. Here's the original problem as it is in the book (pause 5 seconds). Leah, what do I do first?
>
> Leah: 5 times 6, add 1.
>
> Emily: All right. So 31 over 6. Now what?
>
> Leah: Times 12 over 1.
>
> Emily: I'm just rewriting it, I'm not even doing any multiplication yet, I'm just rewriting it. Ok? (pause 3 seconds) Now what? Mike, what do I do next? (lines 376–382)

The framing talk strategies used most frequently were: following the book (traditional; used by 12 instructors), connecting to real-world context (meaning-making; 9 instructors), knowing names (student-support; 7 instructors), setting expectations (traditional; 7 instructors), and assigning individual work in class (meaning-making; 7 instructors). We coded a total of 401 strategies, 174 (45%) of which were traditional, 112 (29%) meaning-making, and 103 (26%) student-support.

Table 4 presents the proportion of framing talk strategies in each of the three main teaching approaches for each instructor. Note that all the strategies that Elliot used during framing talk were classified as traditional, whereas only 19% of Emily's strategies were traditional; in her case over half were student-support. On the other hand, Elizabeth, who had the

Table 5
Percentage of Novel Questions, by Instructor (*N* = 1,354)

Instructor	Total Instructor Questions per Class Period[a]	Percentage of Instructor Novel Questions
Earl	123	21
Edward	85	28
Edwina	17	12
Elena	176	16
Elijah	90	12
Elizabeth	73	35
Elliot	89	16
Elrod	109	43
Emily	92	14
Emmett	44	33
Erik	163	3
Erin	148	18
Ernest	99	27
Evan	46	26
Average	97	20

[a]The number of questions per instructor is scaled to a class period of 85 minutes and averaged for those instructors with more than one class coded.

highest proportion of meaning-making strategies, 52%, had the least proportion of student-support strategies, 8%. This analysis illustrates how during instruction, these teachers use strategies from more than one of the three approaches.

Mathematics Questions in the Classroom

Our third analysis examined the novelty of teachers' mathematical questions. Earlier we defined instructors' novel questions as those questions that open opportunities for students to explore the content and seek to make connections to other contexts or previous knowledge. In all, instructors asked 1,354 mathematical questions, of which 275 (20%) were novel. Table 5 presents the frequency of questions asked and the proportion of novel questions asked per class. The large number of mathematical questions that instructors asked in these classes is noteworthy: On average, instructors asked 97 questions per 85-minute period, with only three instructors asking less than half the average per class (Evan, Emmett, and Edwina). Thus, an average instructor asks more than one mathematical question per minute.

There was a wide variation in the frequency of mathematical questions among instructors (*SD* = 45.31), which suggests, unsurprisingly, that each instructor manages interaction through mathematical questioning differently.

Two instructors (Earl and Edwina) used more than one-third of class time in activities that had students working at their desks. The most noticeable finding is the small percentage of novel questions asked per class, a finding that is consistent with other studies in math and science college classrooms (e.g., Barnes, 1983). Half of the instructors asked less than 20% of novel mathematical questions. Only Elrod asked more than 40% novel questions in his lesson. It is interesting to note that Erik, who asked the second highest number of mathematical questions per class (163), asked the smallest proportion of novel questions, 3%.

The following excerpt from Emily's arithmetic class, in which they are working on reducing fractions, illustrates the context in which questions are asked and the codes (in bold) that we assigned to each of these questions:

> Emily: Twenty one, 56 over 24. Well, make it a little bigger than that, that's hard to see.
>
> F: Sorry.
>
> Emily: My goal today is to get you all also covered with chalk, right? (**Not Coded, non-mathematical**) (writes on board 8 seconds)
>
> F: Using 8.
>
> Emily: Ok.
>
> F: So you want me to show it?
>
> Emily: Why did you, how did you know to use 8? (**Novel, pressing for a non-routine explanation**) That's where I think people, that's where I have trouble relating to it, how did you know to use 8? (**Novel, pressing for a non-routine explanation**)
>
> F: Because 8 goes into both of them.
>
> Emily: Ok. Did you just look at those numbers and say oh those are both multiples of 8? (**Routine, confirming a fact**)
>
> F: This one yes, but not the other one.
>
> Emily: Ok, what do you do if you don't know right away? (**Novel, pressing for a non-routine explanation**)
>
> F: I keep just experimenting with the numbers, getting closer. (lines 156–172)

In this excerpt, Emily assists a student who is on the board in making explicit her thinking in reducing the fraction given. After a student responds with an answer that could have been accepted as correct, Emily asks "Why did you, how did you know to use 8?" This novel question is meant to have the student make explicit the reasons she had for using that particular number and to explain her thinking in choosing that number. By doing this, Emily not only seeks to see the extent to which the student herself understands the thinking process but seeks to make that thinking available to the rest of the class. As the student does not provide much detail on how she thought through the problem, Emily asks her a yes/no question, through which we learn that the student did use different strategies, after which Emily presses the student for how she approached the solution, who describes trial-and-error, a common problem-solving heuristic in mathematics.

Combining the Three Analyses

The Spearman analysis reveals that how instructors describe their instruction during interviews is highly correlated to the framing talk used when teaching ($\rho = .659$, $p < .05$). That is, instructors who tend to describe their practice as more content-centered (traditional approach) will use more content-centered strategies in the classroom, and instructors who describe their practices as more student-centered (meaning-making and student-support approaches) will use more student-centered strategies when teaching. More interestingly, however, is that none of these indices is correlated with the use of novel mathematical questions in the classroom ($\rho = .379$, *ns* for index from interviews, and $\rho = .237$, *ns* for index from observations), suggesting that teachers describing and using student-centered approaches are not more or less likely than teachers describing and using content-centered approaches to use a higher proportion of novel questions with their students.

Discussion

Our first research questions asks, "What is the relationship between teaching approaches that instructors espouse during interviews and the teaching approaches that instructors enact in their classroom?" Whereas in general there is skepticism about the alignment between descriptions and enactment ("Do as I say, not as I do"), in this study we found that the ways in which the faculty described their teaching were well aligned with the framing talk that they used as they organized instruction in the classroom. Unlike K–12 teachers participating in reform efforts, where such mismatch is commonly reported (see e.g., Cohen, 1990), our instructors do not feel pressured to describe attempts to reform their practice; they are also confident about their teaching skills and feel proud of their work with their students. Thus, it is probably not surprising that their descriptions were quite consistent with the framing talk they used. This finding also suggests that either interviews or classroom observations can be used to describe teaching approaches. Because we believe that classroom observations are foundational to understand instruction, instead of using interviews to describe teaching approaches in general, they could be more productive in gathering information about teacher actions and decisions in a subject specific classroom (e.g., mathematics).

Our second research question asks, "What is the relationship between the use of novel questions and instructors' description and use of teaching approaches?" Our analyses suggest that there is no relationship between using novel questions and using any particular teaching approach. We did not find an association between the proportion of described approaches and teaching strategies and the proportion of novel questions asked in the classroom. One possible explanation has cognitive roots: Perhaps framing talk (which aligns well with interview data) helps teachers organize their own thoughts, while questions (which do not align well) are meant to help organize (or elicit) others' thoughts. In this sense, the teacher might have better control, and presumably alignment, with his or her framing talk and less with novel questions, resulting in the associations we see here. We propose that the way in which instruction is conceptualized in this setting, in terms of how mathematical content, instructors, students, and the institutional environment are perceived, plays an important role in accounting for our findings.

Mathematical Content

The content of the courses taught at community colleges is described as either too rigid (i.e., there is only one way to solve or model certain problems) or too basic (i.e., most meaningful mathematics is seen in higher courses such as calculus). Because of these two features, math topics are perceived as unsuitable for asking questions that invite students to explore the knowledge or to connect it to other mathematical notions. A third feature, the amount of content that needs to be covered, de facto imposes limits on the time available to teach. It is possible that instructors might prefer to sacrifice using novel questions in teaching, as these will take more time to manage, and instead fulfill their obligation to cover the material (Mesa & Celis, 2013). These features together could also explain the frequency of traditional approaches described and used by these instructors: They help privilege knowledge transmission and covering the content that needs to fit in a certain period of time.

We found some evidence that the level of the class, remedial or nonremedial, did not necessarily limit instructors' opportunities to ask novel questions (e.g., Emily's arithmetic class). This is consistent with the literature in K–12 mathematics that suggests that novel questions can be asked with any type of mathematical content, at any age or level of expertise (Doyle, 1988; Schoenfeld, 1989; Stein, Grover, & Henningsen, 1996). Observations of more advanced classes (calculus, advanced calculus for engineers) show a low incidence of novel questions as well (Mesa & Chang, 2010), which suggests to us that the low number of novel questions asked might be a characteristic feature of teaching mathematics in postsecondary institutions that transcends levels. It might be the case, however, that some mathematical subjects can be more suitable for proposing novel questions. In the case of Elrod, the high frequency of novel questions that he asked could be a consequence of teaching a statistics class. Because of its direct or intuitive connection to real situations, it is possible that statistics, and other courses like it, offers more ways to ask novel questions than the more basic or calculus-oriented classes. This possibility needs to be explored further.

Instructors

Research on teacher knowledge suggests that instructors' mathematical knowledge for teaching has an impact on the quality of the mathematics done in the classroom (Ball, Lubienski, & Mewborn, 2001). We observed two instructors teaching the same course and content and providing remarkably different explanations to deal with a student's confusion about the procedure to subtract improper fractions with unlike denominators. One instructor was able to give several different examples to illustrate the procedure, connecting the situation to the real-world context of money conversions; she also drew different representations of the problem and asked several novel questions, to the student and the class, in the process. The other instructor, facing exactly the same student confusion, kept asking the same routine question, did not bring in alternative representations, and did not connect the content to a more concrete situation (e.g., money) that could have helped clarify the procedure. Both instructors more frequently described student-centered approaches (meaning-making and student-support approaches), but they exhibited different levels of this specialized knowledge for teaching mathematics that could help their students understand mathematical ideas. Our study did not explore instructors' mathematical knowledge, but we see this as a crucial avenue for further investigation. On the other hand, when instructors are not constrained by their knowledge of mathematics, as is the case of the framing talk, we see greater consistency between what they say in interviews and what they do in the classroom.

Students

Students were described as coming from a "spoon-fed" tradition, having little time to work on their homework after work, being resistant to participate in public classroom discussion, and feeling insecure in their mathematical ability. These descriptions resonate with Cox's (2009) work with community college students in composition courses. These perceptions that students "need" assistance might influence how teachers support their students and how they think they can best help students create meaning out of the work. In the interest of demonstrating to the students that they can answer mathematics questions and, therefore, that they can learn, instructors may ask questions that they think their students will be able to answer by using questions that are usually based on ideas that students have already seen or that they are more familiar with. In this regard, routine questions play an important role in boosting students' confidence, but simultaneously, making the teacher essential: The material is accessible to the students only through the teacher mediation, thus maintaining the impression that it is difficult for students as individuals to access mathematics on their own. Novel questions may implicitly send the message that when students struggle (which is anticipated with novel questions) they are not capable of doing mathematics, something teachers do not want to do.

We suspect that these same perceptions about the students would not necessarily change the way in which teachers frame their talk in the classroom. Calling a student by name (or not) or praising them in front of others (or not), telling jokes, or reminding students of the standards are strategies that teachers use. An instructor who is concerned about student confidence in their mathematical knowledge might avoid calling the student by name (it will be too embarrassing) or will call the student by name to make sure he or she has something to contribute (therefore helping to disrupt students' misperception). Thus, who the students are would not necessarily influence teachers' framing talk or make it inconsistent with teachers' approaches to teaching. It would be worthwhile, however, to test the potential interaction between content and student perceptions, given some recent findings that students' self-efficacy perceptions vary by type of course and that instructors might have misaligned perceptions of their own students' self-efficacy (Mesa, 2012). Moreover, students' self-efficacy beliefs has been linked to intention to major in a STEM field (Wang, in press).

Institutional Environment

Two features of institutions, the established course syllabus and student placement, can be used to understand some of these findings. Departmental stipulation about the content to be covered was frequently mentioned as constraining instructors' work. The content is so vast that instructors feel forced to deliver it quickly so that they can feel that they have at least fulfilled their obligation to present all the material to the students. A traditional approach can be very efficient because it fulfills the teachers' responsibility in the implicit teaching and learning contract: The material is presented, the students are exposed to it, and students are assessed through tests of proficiency with content that was presented during class (Brousseau, 1997). In this setting, novel questions can be perceived as unfair (students don't know the material), or time-consuming (they would require long discussions), or requiring material not stipulated by the department. Thus, these features will favor asking routine questions over novel questions.

Inaccurate student placement was mentioned as influencing teachers' decisions in teaching (e.g., Elliot and Elrod). When ill-prepared students are placed in classes that are beyond their level, instructors have to either adapt their courses to accommodate students' underpreparation or avoid dealing with students' misunderstanding in order to keep the pace. It appears to us that the institutional environment rewards the latter option (Mesa & Celis, 2013). Further studies are needed to understand how institutional policies influence instructors' decision making in the classroom as it pertains to mathematical content. The teaching approaches that teachers describe address how they deal with these issues in the classroom at a general level; again, teachers who tend toward student support will frame their talk in ways to demonstrate their genuine concern for students, by giving personal phone number or by being very explicit about the course standards. Again, in either case, there is no reason to believe that the institutional features would pressure the teachers into using framing talk that is inconsistent with their described teaching approaches.

In summary, according to our analysis, framing talk strategies are consistent with how instructors describe their approaches to teaching. We suggest that when intending to implement student-centered approaches, the "mathematical knowledge for teaching" needed to enact that type of instruction represents a special challenge. Therefore, promoting a student-centered approach in mathematics classes requires incorporating specific strategies with specific disciplinary knowledge and taking into account the institutional contexts. This knowledge will be especially important given the relatively low percentage of novel questions these teachers asked. Our work suggests that the analyses of approaches to teaching must consider the opportunities that teachers give students to actually engage with the content.

Limitations

Community colleges in the United States are not homogeneous institutions. They vary according to their surrounding community, size, infrastructure, students' demographics, and state policies. Our site represents a large community college with several universities and other community colleges within 50 miles. Thus, our results might not be generalizable to community colleges with other characteristics. All of the instructors in our sample volunteered to participate in this study and most were recognized as "good" teachers by their institution and their students. This implies that our results might not be applicable to all mathematics instructors at community colleges, especially in those cases in which the teaching is below the standard expected by the institution. Another limitation relates to the scope of our method and analysis. It is possible to identify inconsistencies that are a product of a lack of shared understanding between us—the researchers—and the instructors (Speer, 2005). For instance, when instructors said that they are interested in promoting "learning to learn" in their classroom, they may have in mind a different type of classroom interaction than the one we envision using the literature on exemplary practices in mathematics teaching. We sought to minimize this problem of interpretation by triangulating our coding using different sources, seeking concrete evidence, and extensively discussing the evidence we had. This process leaves less room for varying interpretations of teachers' statements.

Conclusion

We have illustrated that instruction, defined as the interaction between teachers, students, and content within specific environments, is a powerful conceptualization that allows us to investigate it in a particular setting and a specific discipline. Our study makes a contribution by combining previous frameworks from different research traditions and providing more detailed lenses with which to analyze interactions in mathematics classrooms and the connection between these interactions and instructors' espoused approaches. We believe that community colleges present important challenges that are unique, therefore creating a rich space for testing theory.

An important conclusion of this work is the need to look at instruction in the content areas and within specific environments so that we can understand the complexity of teaching and can devise content- and context-sensitive strategies that can assist faculty in creating classrooms that allow them to know more about their students' learning. Our findings also suggest that categorizations of teaching approaches need to include classroom interactions so that these approaches can inform and influence teaching practice in higher education.

An important area of investigation deals with establishing connections between teaching approaches, classroom data, and students' learning. In this article we have only hinted at the opportunities to learn that questioning practices may create and found that using student-centered approaches does not necessarily imply more frequent use of novel questions. What do students learn and understand when they experience particular teaching approaches? We speculate that such a study will require going beyond using grades in courses or surveys on generic content and instead engage in analyses of students' classroom contributions and interviews with students as they solve mathematical tasks, capitalizing on similar methods pioneered in K–12 classrooms. A recent study (Stigler, Givvin, & Thompson, 2010) suggests that performance on tests or behaviors in the classroom might misrepresent what students understand and know about mathematics. A related analysis could investigate how novel questions are used in the classroom. We have found that trigonometry instructors tend to answer about 30% of the novel questions they pose or to restate them in ways that reduce the complexity for the students (Mesa & Lande, in press). Although reducing the novelty of questions might be seen as an interest in showing students how to deal with unknown situations, it is not clear that students are actually given opportunities to work through the process of answering novel questions.

One intriguing finding for future research is the different approaches that instructors appeared to use when they were teaching students in remedial courses as compared to the approaches they described and enacted in teaching students in nonremedial courses. It seems that instructors teaching remedial courses in this college tended to describe and enact approaches consistent with student-support. This suggests a welcoming attitude toward underprepared students, a necessary element that contributes to classroom success in remedial education (Grubb & Cox, 2005). At the same time, the trend of using mostly routine questions in these classrooms is worrisome, as such practice will likely hinder students' opportunities to experience challenging mathematics and might undermine their options to enter professions in which a more sophisticated relationship with mathematics is necessary.

Consequently, our findings have implications for faculty development. They suggest that the quality of teacher-student interaction with mathematical content is an important feature of the classroom and that instructors both need to understand the process of creating novel questions and the impact of using them in their classrooms. It might be also possible to capitalize on the framing talk strategies that teachers use as a way to draw instructors into this process. Discipline-based faculty development that acknowledges the need to create these opportunities for students, and that seeks to understand the constraints under which instructors work, would be an important path for future research.

Notes

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[1]A review of the literature related to mathematics instruction in community colleges yielded no studies that attended to how classroom processes are conducted: The term *instruction* is confounded with *instructors* (i.e., part- vs. full-time), *curriculum* (i.e., the courses that students take), *assessment* (i.e., the grades students obtained in their math courses), or *pedagogical innovations* (e.g., whether graphing calculators, group projects, or writing is used; Mesa, 2008).

[2]The interview protocol is available from the authors.

[3]A further refinement of this framework using Gregory and Jones (2009) yielded a more nuanced categorization into six categories. As these are not necessarily germane to the discussion in this article, we do not elaborate them in here. A discussion of these is available from the authors.

[4]In the interview we attended primarily to the following sections: introduction, teaching practices (seven questions), conceptions, philosophies of teaching, personal influences on teaching (four questions), and instructor perceptions of students (five questions). Most passages were the full responses to questions asked. If there were different ideas in a response, we considered that response as multiple passages. The interviews were chosen to maximize the differences perceived among instructors, after an initial reading of all the interviews.

[5]A first step before coding consisted of identifying the framing talk text in the transcripts. Because we had already identified mathematical questions, the rest of the text became the basis for coding for framing talk.

[6]Index from interviews: percentage of codes from interview transcripts that were classified as traditional. Index from framing talk: percentage of traditional framing talk strategies used by instructor i – (percentage of meaning making + student-support framing talk strategies used by instructor i) (minimum = −93, maximum = 43, M = −20, SD = 38). For example, Elijah used 11 out of 14 traditional strategies (79%), 1 out of 9 meaning-making (11%), and 3 out of 8 student-support (38%). Thus, Elijah's traditional framing talk index is 30 (30 = 79 – (11 + 38)).

[7]At this college, every 3 years the department gives a common test to all students taking a given course. If less than 70% of the students pass the examination, a curriculum committee is formed to determine curricular changes that will investigate the reasons for the low passing rate and to propose measures to address the identified problems.

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