Classroom Participation in Pre-College Mathematics Courses in a Community College

Vilma Mesa

University of Michigan

Ann Arbor, Michigan, USA

vmesa@umich.edu

Abstract

The purpose of this paper is to present results of a qualitative study that seeks to describe classroom interaction features in pre-college mathematics classes taught by a group of seven faculty considered to be successful in their community college. An analysis of the classroom participation patterns and of the forms and functions of the questions asked reveals a complex picture that departs substantially from accounts of classroom participation present in the literature in higher education. At the same time, other features of the interaction, suggest that the complexity of students' participation is low, thus, calling into question the push for more 'student-centered' classrooms in this setting.

By obtaining a higher education degree an individual benefits the society at large in terms of income, health, and civic behavior (Baum & Ma, 2007). For many individuals, the rising costs of higher education have made the community college a natural, and in many cases, the only, option for completing postsecondary studies (Dowd *et al.*, 2006); indeed, nearly half of the undergraduate population in the United States is enrolled in a two-year college (Baum & Ma, 2007). National completion and transfer rates for students in public two-year colleges are low (22 percent and 18 percent, respectively, Dowd et al., 2006; Knapp *et al.*, 2006), however, thereby creating pressures on the administration and faculty to increase the number of students who complete their studies. Because mathematics is an almost universal requirement for all students in community colleges (Lutzer *et al.*, 2007), math departments have to spend a considerable amount of resources in preparing the large number of students who are not ready to take on college work. In this sense, the mathematics and English departments are similar; however, for mathematics the problem is compounded because students often bring higher levels of anxiety towards the subject, a consequence of repeated prior failures in the subject (House, 1995). It is likely, therefore, that the way that mathematics is taught plays a significant role in helping community college students earn a higher education degree.

Recent calls from the *Standards* document, *Beyond Crossroads: Implementing Mathematics Standards in the First Two Years of College,* (Blair, 2006) explicitly calls from moving from a 'teacher-centred' instruction model to a 'student-centred' one in which students take an active role in their learning. 'Lecture,' however, is very common in this setting. According to the 2005 Survey of undergraduate programs in the United States conducted by the Conference Board of Mathematical Sciences [CBMS] the percent of sections in which lecturing was the standard mode of instruction ranged from 64 percent (arithmetic and math modelling) to 93 percent (differential equations). However, what counts as lecture is an open question. Because there are no systematic studies of instruction carried out in community colleges (Mesa, 2008), we do not know how much students participate, what types of questions they ask, and what is the level of their engagement in classroom. I contend that before attempting a change of instruction is necessary to understand the current conditions in which instruction is happening. Also, because the research supporting the need to move towards a student-centred instruction model has been conducted with K-12 students it is a second open question whether the connections between student-centred environments in community colleges yield the same results as with the much different school population.

In this paper I present a first attempt to characterize classroom processes (student participation and questions instructors ask) in pre-college mathematics classroom in one community college. I start by reviewing some of the literature on classroom participation in undergraduate settings, then I present the methods used to collect and analyse the data, and then I present findings. I conclude with some implications for research and practice.

Literature Review

I use the term *instruction* to mean the *shared work* on authentic mathematical content between instructors and students within environments—the classroom, the school, and the community (Cohen *et al.*, 2003). Figure 1 depicts these elements; the arrows indicate the interactions that occur among them. The inner circle corresponds to the classroom, the larger circle to the school or the community in which the classroom is embedded. The figure also highlights that students can interact among themselves, thus acknowledging that they can be "instructors" to other students, too.

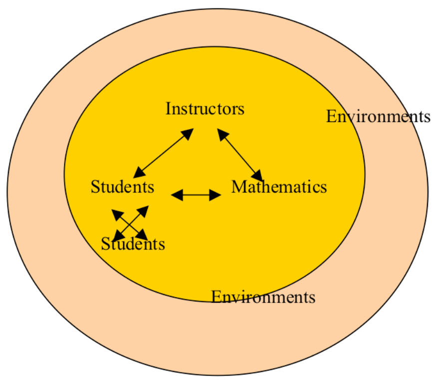

Figure 1: Instruction as Interaction. Adapted from D. K. Cohen *et al.* (2003, p. 124).

In the model, the arrows between Instructors and Students and Mathematics (the instructional triangle) correspond to the work that teachers have to do in order to engage students in learning. A first step for me, is to characterize the interaction between instructors and students in mathematics courses taught at community colleges. I do this by looking at participation patterns and at the forms of questions that instructors ask in the classroom.

Classroom participation in undergraduate classrooms

Studies in higher education have looked at classroom interaction to uncover patterns of participation that might exclude some groups from it and highlight the role that instructional practices have on the interaction patterns. The "chilly climate" hypothesis, for example refers to patterns of interaction that occur in college classrooms that prevent females or minorities from participating actively (by asking questions or offering answers) and that lead them to leave or change degrees for which they are highly qualified (Hall & Sandler, 1982; Williams, 1990). Fassinger (1995) reports that there is evidence that females in general participate at lower rates than males independently of the discipline but that there is mixed support for how much such behaviour depends on the instructors' gender, although there is evidence that both males and females participate more with female instructors. Fassinger reports results of a survey of 51 classrooms in a liberal arts college in the Midwest that surveyed over 1000 students about their levels of classroom participation and some of the reasons they had for such participation level. She found that although there were differences in the factors that determined male and female participation, aspects such as student confidence, class size, and level of student-to-student interaction were more critical than gender or participation grade. She also found that there were no instructor factors that could be associated with the different participation levels of the students. In this study, classroom participation was defined as comments or questions students offered during class and it was assessed via Likert type items. In a follow-up study, Fassinger (2000) analyzed the same data set using the class, not the individual students, as the unit of analysis. She found that classes in which participation was high (measured as students offering an average of 12 or more interventions in a given class) had "more cooperative, supportive, and respectful classroom dynamics; [patterns of interaction were] more inclusive, less teacher-centred, more tolerant of student input, their members [were] more confident, and their professors seen as more approachable and supportive" (p. 45). Studies such as these clearly attend to two important dimensions of classroom participation, namely the students' personal positions and perceptions of the value of participating as well as the role that instructors play in shaping the interactions (e.g., by generating a student centred class). In these studies, classroom participation is seen from the students' perspective, which might be prone to over or under-estimation of the actual participation that occurs in the classroom. Observational students might provide a better account of what actually occurs in a classroom. In this study, I sought to determine what differences there were in the participation patterns of males and females in the pre-college mathematics courses taught at one community college.

Questions in classrooms

I look at the role of questions in classrooms from two perspectives. First I look at how much wait time instructors give once a question is uttered, then I look at the function of the full pattern that includes also student's answer to the question and the instructor's evaluation of that answer.

Wait time

One feature of undergraduate classrooms is that instructors ask questions for which little wait time is given (Duell *et al.*, 1992; Tobin, 1987). On average, instructors wait less than 3 seconds when they ask a question that requires an answer, such as "Are there any questions?" Increased wait time (3 seconds or more) has been systematically associated with higher student participation and increased complexity of the students' responses (Duell *et al*., 1992). Thus, I sought to determine what proportion of questions that instructors asked required an answer from the students, and of those what proportion of questions had an appropriate wait time.

IRE patterns

Originally identified by Mehan (1979), the Initiation-Response-Evaluation [IRE] pattern has been identified as a characteristic of pedagogical interaction in classroom settings. "The sequence starts with a teacher's question, followed by the student's answer in the second turn. The turn routinely goes back to the teacher who offers feedback on the correctness or adequacy of the second turn answers" (Lee, 2007, p. 1205). In general the literature has been critical of these patterns of interaction, as they are perceived as authoritarian modes of delivering instruction (the instructor already knows the answers), that aligns students' with the teacher's agenda without giving them the possibility to offer other insights they might have. In addition, because the purpose of the third turn is assumed to assess or evaluate the appropriateness of the response, students are not given the opportunity to reason on their own about the correctness of the answer, that is the teacher is confirmed in his or her role of knowing all there is to know about the material (Cazden, 1986; Lemke, 1990).

However, a more nuanced position regarding the use of IRE patterns and its variation is taking more prominence in the literature, in particular of studies of second language acquisition. According to this position, the role of the instructor's third turn is far more complex than simply evaluating: instructors have to "come to terms with far more local and immediate contingencies than what is projected by blanket terms such as 'evaluation' or 'feedback.'" (Lee, 2007, p. 1205). This is the stance that I have adopted as I look at these transcripts in which a large number of talk revolves around IRE patterns and its variations. Nassaji and Wells (2000) for example have classified the third turn into six functional moves: (1) evaluation, (2) justifications, (3) counter-argument, (4) clarification, (5) meta-talk[1], and (6) action, which help the teacher to position him or herself as giver of information and as manager of the discussion. In addition, Lee (2007) has made the point that whereas pre-determined categories are useful in the description, they hide contingent contexts to which the teacher reacts in order to sustain the interaction; moreover, Lee argues, the contingent properties "do not represent unplanned and random work; rather they show the intelligible organization of language use" (p. 1210).

Assuming this position allows me to perceive classroom interactions as "orderly, reliable, and stable … through the competent work of understanding by teachers and their students who make sense of and act on each and every turn in the course of their interaction." (p. 1210). Lee's analysis, based on analysis of teaching of English to non-native speakers, identifies five types of contingencies, (1) Parsing (by which the instructor seeks to decompose a complex idea for the students), (2) Steering the sequence (by which the instructor attempts to steer students to a particular direction), (3) Intimating answers (by which instructors seek to hint students into providing the answer he or she has in mind), (4) Discovering language learners in action (by which non-native speakers become aware of their language proficiency), and (5) Class management (by which the instructor seeks to maintain order in the room). Of these the fourth one is the less applicable to my needs, so I took it to refer it to 'Discovering mathematics learners in action.'

Because these studies have been conducted either with elementary science students (Nassaji & Wells, 2000)or with undergraduate students learning English (Lee, 2007), I sought to determine whether these patterns were also present in the classes I observed. The main purpose was then, to determine the applicability of these categorizations into pre-college mathematics courses taught at community colleges.

Before describing the study, I provide a brief description of the context of mathematics departments in community colleges in the United States.

Mathematics Education in Community Colleges

Currently there are about 1,150 two-year colleges in the U.S., enrolling near 10 million students, with about 66 percent of them taking classes for credit (Blair, 2006). In the school year 2001-2002, 53 percent of all undergraduate students in the U.S. were enrolled in two-year colleges. The average age of a community college student is 29 years; about 36 percent are 18 to 21 years old, and 15 percent are 40 years or older.[2] More women than men are enrolled (58 percent are women) and 33 percent are ethnic

[1] Meta-talk in functional language refers to cases in which teacher and students focus on the linguistic code rather than on content. There were very few instances in which such focus on language happened in these lessons.
[2] A number of students are also underage, as they can enrol in a community college to obtain a high school diploma (Hébert, 2001).

minorities. In 2001-2002, 61 percent of the students took a part-time course load, 80 percent were employed, and 41 percent were employed full time. Last, but not least, community colleges have an open-door admission policy with mandatory placement testing in reading, writing, and mathematics for first-time students. All these features combined make of the community college a very particular setting in the postsecondary education landscape.

According to the last CBMS report (Lutzer *et al.*, 2007), in 2005 nearly 1.7 million students (48 percent of all the enrollments in undergraduate mathematics) took mathematics courses in public two-year colleges, an increase of 26 percent from the reported figure in 2000 (Lutzer *et al.*, 2002). About 57 percent of the enrolled students took developmental (pre-college) mathematics courses, 19 percent took pre-calculus, and 24 percent took college-level classes (e.g., calculus, statistics, linear algebra, mathematics for elementary teachers).

The survey reports that compared to other reform practices such as using technology (graphing calculators or online resource systems) and assigning group work, writing, or computer projects in pre-college courses, lecture was by far the most common instructional practice used. While graphing calculator use ranged from 2 percent to 33 percent in remedial and non-technical mathematics (nursing or business), between 64% and 77% of the pre-college courses reported using lecture. Writing assignments and group projects were likewise rare in pre-college courses (10% and 5% respectively). Computer assignments, to be completed outside class, were more evenly distributed across courses (between 13 percent and 49 percent).

It is against this backdrop that this study was started. The figures regarding instructional practices suggest that instruction in this setting leans more towards a 'teacher-centered' model of instruction (rather than the participatory that the definition of instruction as shared work has). The literature also suggests that students' participation in general is low, that males tend to participate more although females tend to participate more in certain 'cooperative' environments, and that students might not be given enough time to think of an answer once a question is asked.

Methods

The study reported herein is part of a larger research agenda that seeks to study the impact of classroom interventions that affect classroom dynamics on instructors' practice and students' learning. The setting for the study is a large suburban community college[3] serving Michigan's southeastern region with an approximate enrollment of 12,000 students and an average retention rate of 50%. The college has two satellite campuses. The mathematics department has 15 full time and 75 part time instructors,[4] and offers an average of 22 different courses per term, including developmental math (e.g., fundamental math, beginning and intermediate algebra), courses for professional degrees (e.g., business, health, and education), pre-college math (college algebra, college trigonometry, and pre-calculus), and STEM track courses (e.g., calculus, linear algebra, and differential equations). Students may transfer to technical, liberal arts, and research universities. Like other community colleges across the U.S., students may also finish their GED. Thus the site is representative of other colleges in terms of location, size, and the composition of the student body and the faculty, and the trends in retention[5]. The focus of attention for the

[3] According to the Integrated Postsecondary Education Data System (http://nces.ed.gov/ipeds/).
4 In 2000, the ratio of Full-Time to Part-Time Instructors was approximately 3 to 7 across the nation (Lutzer et al., 2002, p. 151). This college is far from this ratio, something that has been recognized as a problem at this college (Mesa, 2006).
[5] Less than 50% of students enrolled in developmental courses will take the pre-calculus courses.

study was the instructional practices of seven instructors, four part-time and three full-time[6], nominated by the chair as good teachers (their sections filled up first and their passing rates were above the average for that course), who volunteered to participate in this preliminary study.

Data Collection

There were two main sources of data for the study, interviews with the instructors and classroom observations. The interviews, conducted prior to the observation, were intended to gather instructors' views of instruction and learning, awareness of context, and institutional support for their work. Each instructor was observed at least three times in order to obtain a characterization of students' classroom participation patterns and of the types of questions they asked. After each class, instructors commented on events that happened during the class or assured the observer that the class was representative of other classes given. In subsequent observations, the observer also asked for comments on events that had departed from the previous observation (e.g., calling students by name to answer questions or not sending students to the board) so that we could determine what counted as 'normal' or 'standard' practice and what as extraordinary. The classes were audio taped and extensive field notes were taken about what the students and the instructors were doing, who was saying what, and what was written on the board. During the observation a map of students' participation was constructed. The map identifies students' characteristics, the number of interventions (questions or answers, marked at 2-minutes intervals), where the instructor is physically in the room (marking changes every 2-5 minutes), whether students belonged to a group, and the time at which they arrive or left the classroom (see Figure 2).

The interviews were transcribed noting only pauses in speech. After each observation a narrative was typed that would summarize what happened in the classroom, noting important events that could be revisited later. After three observations were conducted, the audiotape of the class that was thought to be most representative of each instructor's style was transcribed noting pauses in speech and time at which the instructor intervened.

Data Analysis

The interview transcripts were used to create a profile of each instructor; the profile summarized their perceptions of the students, the college, and of teaching. We analyzed the interviews thematically (Bazerman, 2006) to corroborate practices we observed using what they said they did. The main source for the classroom participation analysis was the transcript of each class, the corresponding fieldnotes, and the narrative produced. I concentrated on student participation patterns and the forms of questioning that instructors used.

Student participation patterns

The classroom observation transcripts were analyzed in several stages. First all utterances were identified as 'turns', when the instructor or male/female students intervened. These were tallied to get a sense of how many turns instructors and students took. Using information from the class map (see Figure 2) I identified how many male and female students intervened to obtain a measure of the number of turns that speaking students took. These measures gave, among other things, information on the relative participation of students by gender.

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[6] During the data collection process one of the part-time instructors was hired as a full-time instructor, thus the sample has now four full-time and three part-time instructors.

I also counted the number of words that instructors and students spoke and used these as proxies for length of interventions, by dividing the total number of words by the total number of utterances; I also counted the number of students' turns that were one, two or three words long, to get an indirect measure of the complexity of their interventions.

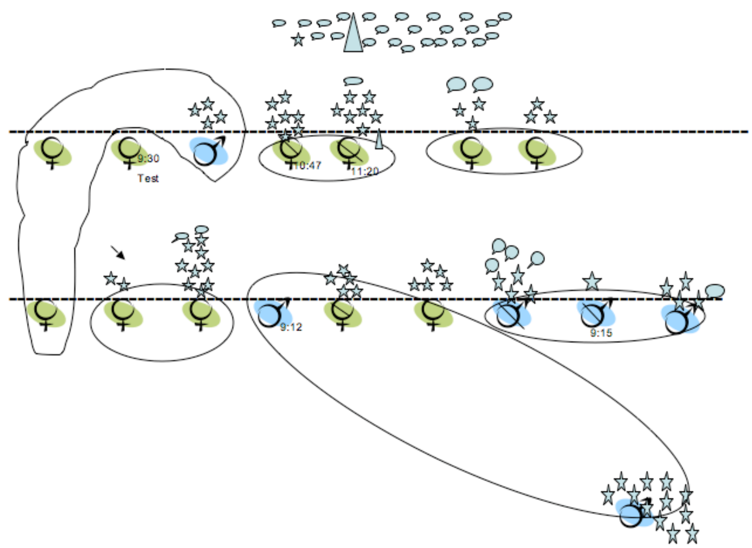

Figure 2: Map of Elena's class. It shows a portion of the number of questions asked and answers provided, as well as the gender of the participants. In this particular map, the lines also show how students organized themselves in groups to work.

Forms of Questioning

Next, I parsed instructors' turns to identify questions the instructors' asked. There were two stages in the identification of questions. First we searched all '?' in the transcript and located the full sentence that ended with the question mark, '?' Then I looked for instances in which the instructors did not finish a sentence, because they were expecting for students to complete the sentence; then I read the transcript searching for all instances in which students intervened and read the paragraphs before to determine whether a questions was being asked.

Once questions were identified, I searched for interactions that followed the IRE pattern and noted all the variations of this pattern (for example, when the instructor instead of evaluating, redirects the question to another student, or when multiple students respond). Once these were marked, I coded these patterns according to the third-turn taken by the instructor into (1) evaluation, (2) justifications, (3) counter-argument, (4) clarification, (5) meta-talk, and (6) action. And then I looked for the variations on the pattern to identify the contingencies to which the third position responded to: (1) parsing, (2) steering the sequence, (3) intimating answers, (4) discovering language learners in action, and (5) class management. The purpose of this analysis was to determine whether they were features of the observed classes or not; because there is only one transcription for each lesson, I did not look for counting how frequent these moves were.

There were four types of questions that did not fall in the IRE categorization, Question-Wait; Question-NoWait, Rhetorical Question, and Sentence-Right? With Question-Wait instructors could ask a question and wait for 3 seconds or more, as in "Are there any questions? (pause 8 sec)" whereas with Question-

NoWait the instructors may ask the question but do not wait (the pause is less than 2 seconds). Instructors also asked questions for which no answer seemed to be expected. This occurred instructors appeared to be talking to themselves, as in "OK, so what should I do here?" or "When we see this, the first thing we do is ask: are there any factors?" These questions, that I called Rhetorical, seemed to serve the purpose of making explicit instructors' thinking and modeling ways in which students could ask questions themselves. Finally the Sentence-Right? question was coded when instructors made a statement and followed it immediately by "right?" as in: "For instance, we would like to see our income rise 300%, but we certainly wouldn't want to see inflation rise 300%, right?"

Rhetorical questions appeared as a prominent feature in some of these classes, and therefore we accounted for them. The last form of question, was suggested by one of the participants, as he considered that such form of questioning was disempowering the students, because would only confirm that what the instructors say is always right; in other words, the instructor claimed, when such form of engagement is used students do not really have room for disagreement. Therefore we included this form of questioning into the analysis.

Results

The results are organized by the two types of analysis conducted.

Student Participation Patterns

Table 1 presents descriptive information on participation patterns in each of the audiotaped classes. The table provides the length of the class, the number of students and of speaking students by gender, the number of turns that instructors and students took, and a ratio of number of turns per student and per speaking student. These numbers were produced to give rough measures of participation: how many people are involved in some form of interaction and how that compares by gender. Because these are taken from a single lesson observed from each instructor (the one that could be considered most typical) they should be taken as proxies of what might occur in a given day, not what occurs every day. The table also provides the number of words uttered by instructors and students as proxies for the complexity (in number of words) of instructors' and students' interventions.

In general over half of the students participated in each class. This result departs from studies that report student participation ranging from 8 to 18 interventions in undergraduate classes (Fassinger, 2000). On average, in the observed classes, there were about two interventions per minute. Thus these classes constitute settings in which students in general have a high participation level.

In all but one class (Elrod's), the proportion of women who spoke relative to all women in the class was larger than 0.5. In contrast in four of the seven classes (Elena's, Emmet's, Erin's, and Erik's), the proportion of men who spoke relative to all men in the class was half or more than half. In only two classes (Elrod's and Emmet's) the ratio of female turns to the number of speaking women was higher than the ratio of male turns to the number of speaking men, which means that in the other five classes the males who spoke tended to contribute more individually than the women who spoke. To some extent, these results suggest that even tough more females than males participate in these classes, males tend to be more vocal, than females, which might support trends noted in other studies in higher education that report that males tend to be more active than females (Fassinger, 1995, 2000; Hall & Sandler, 1982); it might be that because males individually speak out more, they are perceived as more participative.

Table 1: Frequencies and percents of different aspects of classroom participation by class observed.

	Elijah[a]	Elrod[b]	Elena[c]	Emmet[a]	Erin[d]	Erik[d]	Emily[a]
Lesson length (min)	84	92	59	85	100	99	100
Number of Females (Speaking)	14 (10)	13 (4)	10 (8)	8 (6)	4 (4)	10 (9)	8 (6)
Number of Males (Speaking)	11 (3)	14 (6)	5 (4)	8 (4)	10 (5)	4 (3)	12 (3)
Total instructors' turns	225	205	209	183	156	186	197
Total students' turns [e]	213	215	267	183	156	162	171
Female turns	153	91	140	111	29	68	104
Male turns	48	122	78	61	124	77	53
Number of turns per …							
Female student	10.93	7.00	14.00	13.88	7.25	6.80	10.03
Male student	4.36	8.71	15.60	7.63	12.40	19.25	4.42
Speaking female student	15.30	22.75	17.50	18.50	7.25	7.56	14.44
Speaking male student	16.00	20.33	19.50	15.25	24.80	25.67	20.4
Total number of words uttered							
By instructors	6,169	8,096	6,011	8,906	9,350	8,766	9688
By students	1,078	1,499	867	704	750	650	665
Length of instructors' turns	27.42	39.49	28.76	48.67	59.94	47.13	49.18
Length of students' turns	5.06	6.97	3.25	3.85	4.81	4.01	3.89
Percent of turns with 1 word	27%	36%	38%	31%	31%	44%	29%
Percent of turns with 1-3 words	41%	50%	63%	46%	55%	55%	50%

Notes: a. Developmental algebra; b. Statistics; c. College Math; d. Developmental Math; e: The total includes utterances made by more than one student; therefore the number of total turns is higher than the sum of individual male and female contributions.

Instructors, naturally, speak more words than their students. If we look at the ratio of number of students' words to number of their utterances, we obtain a measure of the length of those utterances; in these classes it ranges from about 3 to about 7 words, which suggests that contributions offered by students tended to be in the form of short sentences. We took a closer look at the actual responses and found that the percent of students' turns that consisted of a single word ranged from 27% to 44%; the percent of turns that had 1, 2 or 3 words ran from 41% to 63%; this gives use a sense that the responses that the students offer are, in general, not very complex, at least grammatically (see Figure 3)

Excerpt 1:

T: Mattie?

M: -10 over (5 – 3).

T: Over (5 – 3). Ok. So 18 - 10 (writes on board 3 seconds) And then you still, in the numerator you have 5 - 10. Ok, we need y in the numerator and the x is in the denominator and you subtract. 18 – 10, 5 – 10. 18 – 10 is?

M: 8.

T: 5 – 3 is?

F: 2

T: Then you divide 8 by 2 you get 4 and that's the slope. This is how you calculate slope. This is part of what you did last time. What we're going to do today is applications of this, of slope, real life applications of slope and slope calculations. Ok. The other thing we did on Tuesday is we gave you linear equations. (writes on board 10 seconds) Here's an example of a linear equation. $y = 2x + 5$. This is a linear equation and from a linear equation we can get two things, we can get slope and the y-intercept. Ok. What's the slope of this linear equation?

(Emmet, 15-32)

Excerpt 2:

T: So right here. What do I have? I have a positive 4 and a $-y$, so factor out the $-y$, just like multiplying by a -1, all you do is change the sign. So this becomes negative and this becomes positive. So the resulting quantity is $y-4$.

F: A 4 times the -1, is that what you're saying?

T: Correct. you're working, you're working backwards, you're actually doing (writes on board 3 seconds) and I'm doing (writes on board 2 seconds), by factoring it out I'm dividing, just like multiplying it in, you know when I combine like terms you're multiplying it in, so taking the 1 out, factoring is just the opposite of multiplying. So this is what I'm doing. This becomes negative, this becomes positive.

F: All right. I don't understand what you're saying but I would like to know which example in 6.4 shows me that.

(Elijah, 133-144)

Figure 3: Examples of short and long student's utterances in the audiotaped classes

Forms of Questioning

In Table 2 I present the percent of each form of questions used by the instructors observed. I also included the ratio of number of questions per turn, which gives a sense of the number of questions that instructors asked each time they had a turn. Thus for example, Erin asks two questions within three turns, whereas Elijah asks one question every two turns. This ratio helps in explaining why the participation in these classes is high, as the instructors tend to formulate questions with a relatively high frequency. The first three rows in Table 2 correspond to forms of questions in which students have to provide a response. Notice that altogether these constitute over 60% of the questions asked during the class, with the lowest percent being in Elijah's class (63%) and the highest in Elena's (96%). These percents suggest the high student participation rate might be associated with the large number of questions instructors ask that require a response from the students.

In particular the high percent of questions in which instructors pause for more than 3 seconds waiting for an answer (from 16% in Elena's class to 29% in Erin's class) is markedly higher than what reports in higher education suggest (Ellsworth *et al.*, 1991); in fact in these classes questions in which instructors did not wait for an answer were the exception rather than the norm. Post-interviews with instructors indicated that they rely on visual inspection of students' in the class to determine whether to wait for an answer or not. For example, Emmet said,

> I told them on the first day, ask any questions you want, the only stupid questions are the ones you take home with you without asking… with this class they were, the day you came, I mean they were already used to, I was used to their face. So usually if I asked, "are there any questions," right away they raised their hands. If I don't see the hand like within four seconds or something... That means there's no question. (…) But once I get used to the students' face and I know that if I don't say anything they'll just be quiet, they don't have any questions, I move on. In fact Wednesday, (…) that was only our third meeting, when I asked them "are there any questions?" I would stop and I would scan the entire room, back and forth, maybe for ten seconds, twelve seconds, something like that before I move on. But once I get used to their responses, like if they have a question and they'll respond within two or three seconds, then I make it like four or five. I'm not counting the seconds, but it's automatic, once you get used to that face. (291-301)

Questions in the form "Are there any questions?" appeared both within the Q-Wait category and the Q-noWait category. Q-W also included instances in which the instructors wanted to understand better what a student was saying, for example:

F: Can you give us a nice one for the test?

Elijah: ***Give you what?***

F: A nicer one for the test?

Elijah: This is about as good as they can get. I could make it harder. Here, the one that's actually on the old test is right here that I took this from, this was $4x + 3$.

Table 2: Percent of each form of questioning observed in each class.

	Elijah $N = 105$	Elrod $N = 135$	Elena $N = 148$	Emmet $N = 115$	Erin $N = 228$	Erik $N = 179$	Emily $N = 210$	Total $N = 1120$
Questions for which an answer is expected and given								
IRE	35%	47%	43%	35%	26%	45%	19%	34%
Q-W	19%	20%	16%	23%	29%	28%	23%	23%
IRE Variations	9%	20%	38%	11%	24%	12%	2%	17%
Questions for which an answer is not expected								
Rhetorical Question	15%	8%	3%	17%	7%	9%	12%	10%
Sentence-right?	18%	4%	1%	3%	11%	6%	30%	12%
Q-nW	4%	0%	0%	10%	3%	0%	15%	5%
Number of questions per Number of turns	0.47	0.66	0.71	0.63	1.46	0.96	1.07	0.82

Figure 4 highlights that, except in one case, in these classes more than half of the questions instructors asked were such that they required an answer from their students. These results contrast sharply with classroom observations of college mathematics classrooms conducted as part of a different study in which instructors rarely asked questions that expected a response from the students (Mesa, 2007).

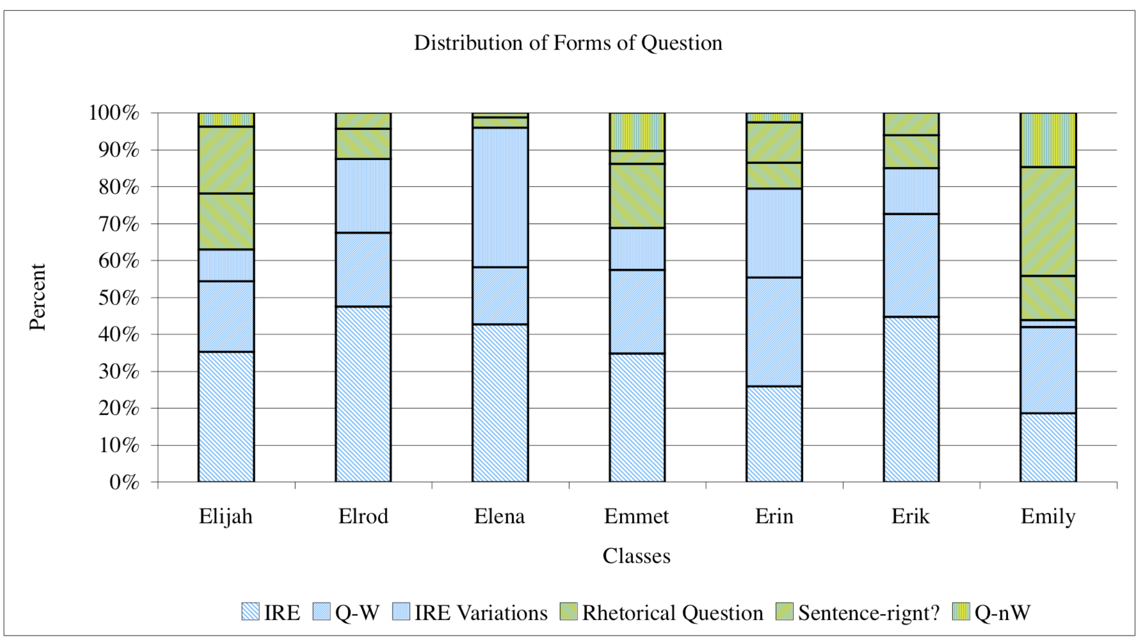

Figure 4: Relative frequency of instructors' questions that require an answer (blue) versus question that do not require an answer (green). Subdivisions correspond to each type of question.

Rhetorical questions were less prominent in these classes, but all instructors formulated them in their teaching. These are questions instructors pose but for which they do not seem to expect an answer from the student. Differently from the Question-no-Wait type, these questions seem to serve the purpose of modeling ways of working and thinking when solving exercises and problems. Figure 5 presents examples of these questions. The emphasized text corresponds to the rhetorical question instructors used.

> **Elijah**: 8, right. So the lowest common denominator is 8. So multiply each fraction by 8. ***Because what does that do?*** This is 8/1, ***what happens?*** These cancel. So these cancel out, so I get rid of this denominator and I get rid of this denominator, so what's left? (lines 449-455
>
> **Elena**: Now notice how if I was mean I could have not asked you about number three and I could have just said probability of a matched pair, ***then you would have had to think yourself about ok what does a matched pair mean?*** Well that means either I get blue, blue or I get black, black. And you would have to set up the problem yourself and I think that's why probability comes difficult because the wording, you have to dig deep into the wording to find out what's really being asked. So let's spend a little bit more time on this conditional probability because I don't think we've done enough with this. (lines 436-444)
>
> **Erin**: ***What do you think about this process?*** He went through and looked for completely filled-in pies and there were three of them and then he went through an looked at the parts and identified that they were cut in the same size pieces, so he could just say ah ha I've got two parts out of pies cut in thirds, ***does that make sense?*** So if you use that strategy [for] number two… How many whole parts do you have? (lines 128-138)
>
> **Erik**: 1/3. So I can write this as 33 1/3% (pause 2 seconds) ***Isn't that weird?*** It is kind of weird. So using the same idea, let's take (writes on board 3 seconds) 2.3 and write 2/3 as (pause 4 seconds) (lines 378-381)

Figure 5: Examples of rhetorical questions instructors asked.

I now turn to discussing the IRE patterns and the variations observed in the sample, as these constitute a large portion of the forms used for all but one of the classes. In what follows I present examples of IRE patterns found in the corpus using the six specific functional moves of the third turn (1) evaluation, (2) justifications, (3) counter-argument, (4) clarification, (5) meta-talk, and (6) action. Then I will present examples of the variations of the IRE patterns as a way to illustrate how instructors responded to each specific contingency, namely (1) Parsing, (2) Steering, (3) Intimating Questions, (4) Discovering Mathematics Learners in Action, and (5) Class Management.

IRE Patterns

Between 19% and 47% of the questions instructors asked were embedded within an IRE pattern. Given the high number of questions that the instructors asked, identifying the IRE patterns was straightforward. Rather than looking at clauses, which is the smallest unit of meaning (Schleppegrell, 2008), we decided to use turns, which are simpler to identify; a turn corresponds to the full speech given by a speaker before being interrupted. Identifying turns in these transcripts was relatively simple, because there were no overlaps or interruptions in the dialog. Regarding the function of the third turn, most of the classes exhibited the six functions described. Examples are presented below. The circled numbers refer to the position of the turn in a given patter, with ① being the Initiation, ② the student Response, and ③ the Evaluation, or third turn. Underlined text marks instructors' questions; emphasized terms in the third turn were used for making the classification.

Evaluation: In evaluation the instructor asserts that what the student has produced is either correct or incorrect. He or she might use laudatory terms, such as "great," "right," or "correct." He or she can also state that the statement is not correct, for example, "No, that is not right," or "no, no, no, no; be careful."

In the classes observed negative assertions by the instructors were rare; more common were instructors' affirmations that the response was correct:

Elrod: ① <u>And how does the grade distribution in this class violate the normality?</u> (pause 8 seconds)

F: ② It's bimodal.

Elrod: ③ It's bimodal, **that's exactly.** It seems like we have two distributions instead of one.

Justifications: In providing justifications, the instructor provides confirmation for an answer the student presents and furthers with an explanation of why the answer is appropriate or correct. The instructor can also use the third position to explain why the answer is not correct.

Elena: <u>What about three, black?</u>

Many: Yeah.

Elena: ①<u>Mutually exclusive or not mutually exclusive?</u>

Many: ②Not mutually exclusive.

Elena: ③Not **because they can happen together**. So whenever anything's defined with a negative you have to be a little bit careful, slow down and think about it. It's not mutually exclusive because they can get together.

Counter-argument: The counter-argument is used when the instructor wants to offer students a situation in which something might not apply; thus the position signals that other possibilities are at stake. The counter-argument might not signal, necessarily, that an answer is not correct.

Elrod: And he's probably not even the richest guy, officially he's just (inaudible). So I said everything in nature's always like this [normally distributed],
① <u>how do you explain this [income distribution] one?</u> (pause 4 seconds)

F: ② An outlier that you normally don't account for, right?

Elrod: ③ Well, **outliers are actually quite typical in income distribution**.

Clarification: in a clarification, the instructor provides an expansion to a previous statement. In the example below, a student offers an explanation (the male) but the instructor, in the third position indicates that 3 is the lowest common denominator, thus clarifying the role of a 3 that was used to reduce a statement:

Elijah: <u>Everybody's good with that answer?</u>

M: No.

F: No because I'd lost you back here. Where did you get that, that extra 3?

Elijah: ① <u>Which extra 3?</u>

F: ② I don't know, you seem to have cancelled...

M: ② You have to multiply everything by the 3.

Elijah: ③ **Everybody gets multiplied by the lowest common factor.**

Meta-talk: in meta-talk, the instructor uses the third position not to refer to content per se, but to features of the language that might affect some meaning. There were few instances of these turns in these classes that made reference to how everyday language was meant to be interpreted in particular problems::

Elena: ① <u>Now does black comma black mean black and black or black or black?</u>

F: ② Black and black.

Elena: ③ Yeah the **comma's going to mean *and* here.**

Action: in action, the instructor uses the third position to give a specific direction about what to do.

Emmet: ① The total cost of the cab ride starts with what?

F: ② $2.

Emmet: ③ $2. So it'd be $2 plus... **and then you add to it $1.50/mile**.

Variation of IRE patterns

Variations in the IRE patterns ranged from 2% to 38% and these patterns included sequences in which the instructor instead of evaluating an answer, followed up with a question, or allowed for several students' responses that were then followed by other questions. As it will be clear from the examples provided below, these patterns responded to contingencies of the particular classes in which they were used.

Parsing: the purpose of this type of pattern is to respond to the need to clarify a complex idea; instructors do this by decomposing it through several turns. In the following example, Elena asks a series of questions, refrains from judging until she gets the majority of the class to agree with the final answer; she does this by interjecting new pieces of information that go from the more general notion (dependent or independent event) to the more particular situation (the clouds rolling a die to decide the rain situation):

Elena: ① Here's one I love, rain on Monday, rain on Tuesday. Independent or dependent?

F: ② Independent.

Elena: ① Why?

F: ② (inaudible)

F: ② I will say independent because it does affect, like if you have rain today that does affect like the probability if there's going to be rain tomorrow? No?

Elena: ① So you'd say it's dependent.

F: ② Sorry, dependent.

M: ② It's only going to rain once...

Elena: ① If it rains Monday **are you slightly more likely to** also have a rainy Tuesday?

F: ② Yes.

F: ② No.

Elena: ① Let me try again. (many talking at once) **Rain on April 7th, rain on April 8th,** independent or dependent?

F: ② Independent.

Elena: ① So at midnight **the clouds are sitting up there and they're going,** "ok roll the dice, are we going to rain today or not?"

F: ② It's not that.

F: ② It's dependent.

Elena: ① Because?

(many at once)

F: ② It's April.

Elena: ③ It's April. That's right and those storm systems they can be big. This is <name of> County, this square, **those storm systems don't at midnight go,** "let's see are we going to rain or not?" Rain. They kind of come in and they come in like at 9:00 at night and then we have rain on Monday and **then they sit around for a while**. Sit around…

Steering: the purpose of this type of pattern is to move students into a different path, perhaps responding to the need to refocus the discussion or to bring an important idea to the discussion:

Erin: ① Ok. So what do you think, if we had to write a statement to add mixed numbers, what's the process that we want to use to add mixed numbers? (pause-7 seconds)

M: ② Change the mixed numbers to improper fractions.

T: ① Did we change the mixed numbers to improper fractions here? ① What did we do, just for right now what did we do? **We may decide later we want to also add another procedure, but for right now** ① what did we do?

M: ② We changed the denominators (inaudible).

T: ① Ok. We just, ok, so what did you say, Katie?

F: ② We added the whole number.

T: ③ Ok, **we added the whole numbers** (writes on board (7 seconds)) ① And then what did we do?

F: ② Added the equal (inaudible).

T: ③ Ok.

F: ② Made the parts equal sizes.

T: ③ (writes on board (4 seconds)) **Add fractional parts and all of you have said** (writes on board (4 seconds)) something to the effect that (writes on board (3 seconds)) **we need to have a common denominator, right?**

Intimating Questions: the purpose of this pattern is to make sure students get to the answer the instructor needs for sustaining the presentation. Here we see Erin looking for a response from the student that could illustrate the need for mixed numbers in the work place:

Erin: Does anybody have a job or a hobby or anything that requires them to add or subtract mixed numbers? (pause-4 seconds) You might be surprised because you go yeah right like I do.

①J., do you have a place?

M: ②Just some I mean home improvement stuff.

T: Home improvement stuff. Right? ①**Give me an example.** Like what might you be doing where you'd come across mixed numbers?

F: ② (inaudible)

T: Ok, barrels of paint, painting. **①What were you thinking?**

M: ②(inaudible) Well out of one of the questions was baseboards. So the borders of the wall.

T: ③ Exactly.

Discovering Mathematics Learners in Action: the purpose of this pattern is to make students aware of their ability to do mathematics and to highlight their proficiency:

Erin: ① What do I end up with?

M: ② 12/8.

Erin: ① Change it to a mixed number.

M: ② 1 4/8.

Erin: ① Otherwise known as? (writes on board (4 seconds)) ③ **There's no stopping you guys. You're good at this stuff.**

Class Management: In this pattern the instructor seeks to call students' attention so that certain order is maintained. There were not many instances of the pattern in the observed, classes, except to make sure certain things were covered or for calling students back into a large group discussion.

Emily: ① So moving on to fractions, (pause 4 seconds) questions on anything we did, any of the homework?

F: ② I have a question on 37.

Emily: ③ 37, hold on, give me a page number and let me write it down.

Discussion

The purpose of this preliminary study was to describe instruction in mathematics classrooms in community colleges. I analyzed two dimensions of instruction, classroom participation and types of questions instructors ask in typical developmental and pre-college mathematics classrooms. I attended to these two particular aspects because undergraduate mathematics classrooms have been characterized as teacher-centred environments in which lecture is the predominant mode of content delivery (Lutzer et al., 2007). The seven classes observed do not fit what can be considered a 'lecture' pattern, as the students intervened quite substantially in any given class. Additionally, the instructors asked a large proportion of questions that required an answer and their questions in general provided ample wait time to encourage students' responses. In these classes women and men participated actively, with more women than men speaking in a given class; interestingly, the few men who participated tended to intervene more than the women who participated, suggesting that some of these classes might have some very vocal males who might exclude other students from answering. The findings also indicate that a considerable number of students' answers are of a low grammatical complexity, which suggests that students' participation might be at a low cognitive level, perhaps at a recall or recognition level: students might not be expected or encouraged to provide long elaborated sentences that would require higher order cognitive activity (Anderson *et al*., 2001).

In my conversations with the participating faculty about these findings, they suggest that the level of the class (pre-college math), the students who take these classes (have experienced failure, low self-esteem, patchy math knowledge), and their own prior teaching experiences with these students justify some of these findings. First, with the exception of the statistics class, all these classes were developmental classes. Students whose score in a placement test suggest that their mathematical knowledge is below college level are required to take these classes. Instructors tended to speak sympathetically about these students, highlighting their high anxiety levels and their low confidence in their ability to do mathematics (result of prior failures). All instructors, when interviewed, expressed that one of their goals was to infuse confidence and reduce these students' anxiety towards mathematics and talked about different strategies they had to accomplish this. Involving students with the material during class was one of such strategies either by assigning work during the session so students could practice or by connecting the material to what they were doing outside the college:

> These are students that (…) I don't know if they've really talked about math much, ever, other than to say I hate it. So my goal is to get them talking about math and to get them comfortable talking about math in a situation that's not threatening. So they, I think they respond well in that it, some of them it helps them just to see that they're not the only ones struggling with a concept. Sometimes it really helps them to teach another student, if I have them explain to your neighbor how you got this problem, you know that's very educational. And I've been doing that, I've done that a little more in my, I haven't done that so much in [math class] yet, I've done that a little more in algebra two, but we've done some of it. So it's, it's the communication about math that they just, I think that helps a lot and I've seen them, just builds their confidence more than anything, which they really need. (Emily, initial interview)

Another strategy instructors used to reduce students' anxiety was availability. All instructors said they were always available via phone, Internet or by making extra appointments with students who needed help:

> Mostly it's dedication. I don't think I'm the most innovative teacher in the world and I'm sure there are folks out there doing far more innovative you know crazy off the wall type stuff with their students. My approach is that I you know I always tell my students there's no bad time to call. I get calls from my students at 2:00 in the morning. You know I work with them all the time and I'm just patient with them. I let them learn, if they have to ask the same question fifteen times and I have to come up with fifteen different answers that's what we do. (Erik, Interview,

Instructors reacted negatively towards lecturing, because they believed that one reason why their students were taking these pre-college classes now was that they had experienced poor teaching experiences in their K-12 education. Thus, felt compelled to try something new:

> I launch the day's lesson which usually involves as short of a lecture as I can get away with (Elena, initial interview)

> I'm a big believer in experiential learning; I'm doing those small discoveries together. Like I put a question up on the board, let them think for a few seconds and they are coming up with the answer. And of course they don't have the right answer all for the first time, but we think through as a group (Elrod, initial interview)

> I don't do any, very little just straight lecture where I'm just giving them information because it's often "tell me what you think, tell me what you know." You know "what do you already know?" or "if I put these problems up what are you noticing?" (Erin, initial interview)

Thus, for these instructors, getting students involved with the material was very important and thus, they created environments in which participation was part of their daily work.

It is somewhat worrisome, that students' answers might not be that elaborated. Thus, even though high level of student participation is important, the content of the participation is also key. The analysis of the form and function of the IRE patterns and its variations suggests that instructors do use that third turn for other purposes beyond evaluation and that the turn responds to contingencies in their teaching. However, instructors' authority is evident in all these turns, as each of the moves described are geared towards the instructor's personal agenda for the problem or the class. Thus, the high participation masks an authoritarian, teacher-centred instruction mode. However, it is difficult to suggest what needs to be done given these results. I contend that at least two more analyses are required to understand better how the interaction is organized, so that the findings can actually provide instructors with tools for re-engineering the ways in which they organize the interaction in the classroom.

First, a linguistic analysis of the instructors' stance using appraisal theory (Martin & White, 2005; Mesa & Chang, 2008) can reveal whether the instructors actively engage or fend off students from the dialog. This type of analysis focuses on specific words instructors use to sustain monologic or dialogic exchanges. Raising awareness of how certain linguistic features can limit students' engagement in the dialog might prove fruitful towards moving towards a more student-centred instruction.

Second, a content analysis of the interactions (Anderson et al., 2001; Mesa & Cheng, 2008) can reveal the type of knowledge (procedural, conceptual, metacognitive) that is required and at what level (recall, apply, evaluate, etc.) This is important, because the premise of creating student-centred environments assumes that students will get more actively involved with important mathematical knowledge. However, it is not clear that high student participation will ensure such cognitive engagement. Making explicit the kind of knowledge that is required might also prove useful in shaping student-centred instruction that is authentic towards the mathematics.

Conclusion

The preliminary character of this study raises more questions than answers. First, the CBMS survey indicates that lecture becomes more common the higher the level of the class. Are the results documented in this study particular to the pre-college classrooms or are they particular to the instructors? Recall that these were instructors who were considered successful by the department chair, thus it is possible to ask, what will happen when these instructors teach college classes? Or what do other less successful instructors do with these same classes? Because some instructors indicated that they vary their teaching style depending on their audience, it is important to know whether and how they modify classroom participation. Second, the characterization of the IRE patterns suggests that the third turn fulfils many functions for the students and for sustaining the lesson. How frequent are those? And similar to the first question, can we possibly detect patters that depend on the content of the class? Or are these particular to the instructors? The answer here is less clear, but we could possibly hypothesize that the forms in which instructors organize their questions and evaluations of students' responses are more personal, therefore more likely to be found in other classes they teach. But this is an open question. Third, a further linguistic analysis as proposed in the last section, using appraisal theory, would give an unprecedented view of how instructors orchestrate the dialog in their classrooms, foregrounding language and back grounding content. Analysis of classroom discourse in undergraduate math classrooms (differential equations) has focused on socio-mathematical norms (Stephan & Rasmussen, 2002) but what is the role that language plays in creating those norms has not been analyzed. Fourth, a closer look at the type of knowledge that is potentially activated during the interaction is fundamental because what matters most is what the students learn and the quality and permanence of that learning. Because community college classrooms have a wide range of students in each class—adult, college-age, full-time employed, with families, low-income—what instructors do in each class is of paramount importance, all the time. The participating faculty are strongly committed to their students' success, but at the same time they feel at a loss in trying to make sense of what their students need to be successful. A core assumption about the importance of students' participation, in 'student-centred' settings needs to be carefully considered. How feasible is it to sustain such student-centred environment? And if instruction is seen as the shared work between instructors and students with authentic mathematics content, what is the place for student (or teacher!)-centred environments? I believe that attention to specific and important aspects of the process of interaction between students and instructors in the classroom can assist researchers in devising strategies that faculty can use on a daily basis to reach their students.

References

Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., et al. (Eds.). (2001). *A taxonomy for learning, teaching, and assessing*. New York: Longman.

Baum, S., & Ma, J. (2007). *Education pays 2007: The benefits of higher education for individuals and society*. New York: The College Board.

Bazerman, C. (2006). Analyzing the multidimensionality of texts in education. In J. L. Green, G. Camilli & P. B. Elmore (Eds.), *Complementary methods in education research* (pp. 77-94). Mahwah, NJ: Erlbaum.

Blair, R. (Ed.). (2006). *Beyond crossroads: Implementing mathematics standards in the first two years of college*. Memphis, TN: American Mathematical Association of Two Year Colleges.

Cazden, C. (1986). Classroom discourse. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 432-463). New York: Macmillan.

Cohen, D. K., Raudenbush, S. W., & Ball, D. L. (2003). Resources, instruction, and research. *Educational Evaluation and Policy Analysis, 25*, 119-142.

Dowd, A., Bensimon, E. M., Gabbard, G., Singleton, S., Macias, E., Dee, J. R., et al. (2006). *Transfer access to elite colleges and universities in the United States: Threading the needle of the American dream*: Jack Kent Cooke Foundation, Lumina Foundation, Nellie Mae Education Foundation.

Duell, O. K., Lynch, D. J., Ellsworth, R., & Moore, C. A. (1992). Wait-time in college classes taken by education majors. *Research in Higher Education, 33*, 483-495.

Ellsworth, R., Duell, O. K., & Velotta, C. L. (1991). Length of wait-time used by college student given unlimited wait-time intervals. *Contemporary Educational Psychology, 16*, 265-271.

Fassinger, P. A. (1995). Understanding classroom interaction: Students' and professors' contributions to students' silence. *The Journal of Higher Education, 66*, 82-96.

Fassinger, P. A. (2000). How classes influence students' participation in college classrooms. *Journal of Classroom Interaction, 35*(2), 38-47.

Hall, R. M., & Sandler, B. R. (1982). *The classroom climate: A chilly one for women?* Washington DC: Project on the Status and Education of Women, Association of American Colleges.

House, J. D. (1995). Student motivation, previous instructional experience, and prior achievement as predictors of performance in college mathematics. *International Journal of Instructional Media, 22*(2), 157-167.

Knapp, L. G., Kelly-Reid, J. E., & Whitmore, R. W. (2006). *Enrollment in postsecondary institutions, Fall 2004; graduation rates, 1998 & 2001 cohorts; and financial statistics, fiscal year 2004* (NCES 2006-155). Washington, DC: US Department of Education; National Center for Education Statistics. Retrieved Dec 2, 2007, from http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2006155.

Lee, Y.-A. (2007). Third turn position in teacher talk: Contingency and the work of teaching. *Journal of Pragmatics, 39*, 1204-1230.

Lemke, J. L. (1990). *Talking science: Language, learning, and values*. New York: Ablex.

Lutzer, D. J., Maxwell, J. W., & Rodi, S. B. (2002). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States: Fall 2000 CBMS Survey*. Washington, DC: American Mathematical Society.

Lutzer, D. J., Rodi, S. B., Kirkman, E. E., & Maxwell, J. W. (2007). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States: Fall 2005 CBMS Survey*. Washington, DC: American Mathematical Society.

Martin, J. R., & White, P. R. R. (2005). *The language of evaluation: Appraisal in English*. New York: Palgrave-Macmillan.

Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Cambridge, MA: Harvard University Press.

Mesa, V. (2006). *Understanding the role of resources in developing collegiate teaching expertise: The case of mathematics textbooks* (Unpublished raw data). Ann Arbor: University of Michigan.

Mesa, V. (2007). *Developing a survey for collecting data about textbook use in introductory undergraduate mathematics courses*. Unpublished raw data. Ann Arbor, MI: University of Michigan.

Mesa, V. (2008). *Mathematics instruction in community colleges: A literature review* (Manuscript under review). Ann Arbor, MI: University of Michigan.

Mesa, V., & Chang, P. (2008). *There is more to classroom interaction than meets the eye: Instructors' language in two undergraduate mathematics classrooms* (Manuscript under review). Ann Arbor, MI: University of Michigan.

Mesa, V., & Cheng, A. (2008). *Content of questions in mathematics classrooms in community colleges* (Manuscript in preparation). Ann Arbor, MI: University of Michigan.

Nassaji, H., & Wells, G. (2000). What's the use of the 'triadic dialogue'? An investigation of teacher-student interaction. *Applied Linguistics, 21*, 376-406.

Schleppegrell, M. (2008). Grammar, the sentence, and traditions of linguistic analysis. In C. Bazerman (Ed.), *Handbook of research on writing*. New York: Erlbaum.

Stephan, M., & Rasmussen, C. L. (2002). Classroom mathematical practices in differential equations. *Journal of Mathematical Behavior, 21*, 459-490.

Tobin, K. (1987). The role of wait time in higher cognitive level learning. *Review of Educational Research, 57*, 69-95.

Williams, D. (1990). Is the post-secondary classroom a chilly one for women? A review of the literature. *The Canadian Journal of Higher Education, 20*(3), 30-42.