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

Preliminary Research Report

Abstract

In this study we compare teaching approaches of 14 community college mathematics instructors with their classroom questioning and their classroom non-mathematical discursive interactions. The teaching approaches were drawn from interviews and the application of an analytical framework derived from the higher education literature. The questioning and the non-mathematical discursive interactions were characterized using transcripts of classroom observations and the application of an analytical framework derived from the mathematics education and higher education literature. From the interviews, we found a wide range of espoused teaching approaches, although the majority of instructors favored instructor-centered approaches. From the observations, we found that these instructors ask a large amount of questions, a sizable proportion of which generate opportunities for students to engage with authentic mathematical knowledge. Also, we found that these espoused teaching approaches are related to observed non-mathematical discursive interactions.

Keywords: classroom research, community college, mathematics teaching

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This study explores the consistence between community colleges mathematics instructors' descriptions about their teaching and a subset of their classroom practices. With this paper we seek to create a bridge between the literature on teaching that exists in higher education and in mathematics education. We believe that it is important to understand how the same phenomenon—instruction—is conceived in each field and seek commonalities and ways to bring these traditions together.

Our investigation started with an analysis of prominent frameworks that have been used in higher education to characterize instruction. In this field the research has focused on "teaching conceptions" and "teaching approaches" (Prosser & Trigwell, 1999; Kember & Kwan, 2000) suggesting that approaches that have a student focus can be more effective than 'traditional' approaches that tend to be instructor- or content-centered (Kember & Gow, 1994; Kember, 1997; Prosser & Trigwell, 1999; Åkerlind, 2003). Most of the studies about teaching approaches are based on analysis of students' perceptions about their learning processes or considering instructors' orientations to teach, obtained mainly through interviews and inventories (Meyer & Eley, 2006; Ashwin, 2009). It is less common to find literature that illustrates teaching approaches based on actual interaction between instructors and students (Ashwin, 2009), and far less common to find studies that look at specific disciplines, such as mathematics.

The literature on teaching in mathematics education is, in contrast more extensive, and is mostly based on in-depth analysis of classroom observations; interviews and inventories are usually subsidiaries to what happens in the classroom. In mathematics education, an important focus has been on the quality of the interactions between teacher, the students, and the mathematical content (Cohen, Raudenbush, & Ball, 2003). Earlier studies of what instructors say in interviews and what they actually do, framed under the agendas of reform promoted by the National Council of Teachers of Mathematics [NCTM] (1989, 2000), highlighted discrepancies that pointed at instructors' difficulties in implementing reform (Cohen, 1990). When looking at instruction in undergraduate mathematics, there are very few of these accounts; the most prominent come from studies with teaching assistants (Speer, 2005; Speer, Gutman, & Murphy, 2005), or with mathematicians (Nardi, Jaworksi, & Hegedus, 2005; Speer & Wagner, 2009; Stephan & Rasmussen, 2002).

We sought to combine these two traditions in an analysis of teaching practices of a group of 14 community colleges mathematics instructors. We sought to investigate, using the frameworks from higher education and from mathematics education, what their teaching approaches were by looking at both, their descriptions of teaching stated during interviews, and their enactments of those approaches in their classrooms. In looking at the work in the classroom, we focused on the mathematical questions that were posed and on other discursive interactions between instructors and the students that were not necessarily mathematical in nature. We wanted to determine the extent to which there was consistency between what instructors declared to be their teaching approaches and what we observed in the classroom. Because of the extensive body of literature in mathematics education, we anticipated discrepancies between the two analyses.

Methods

The data come from a larger study that seeks to characterize community college mathematics instruction. We used interviews and class observations of 14 mathematics instructors (six full-time) at a large suburban community college in the Midwest. Although the observations come from a wide range of courses, half of them were trigonometry courses. The instructors volunteered to participate in the study. The instructors were interviewed prior to the observations to obtain their views about teaching and learning, awareness of context, and institutional support for instruction. The instructors were observed at least three times during the term in which they were teaching. The classes were audio recorded and extensive field notes were collected. Pseudonyms were assigned to each instructor.

To analyze the interviews and non-mathematical discursive interactions of the classroom observations, we used a framework to characterize teaching approaches derived from higher education. The classroom observations were further analyzed using a framework developed for the study that characterizes the questions posed in the classroom. Reliability in using these frameworks to code the data ranged from 69% to 93%.

Teaching approaches framework: We created a six-category framework combining three different perspectives on teaching approaches. For purposes of the comparisons studied in this report, we mainly focus on Grubb and colleagues' (1999) three approaches to teaching at community colleges, "Traditional," "Meaning Making," and "Student Support." The "Traditional" approach would be the most common in community colleges, and among its more frequent actions are controlling time, making reference to higher math courses, and covering the material. The "meaning making" approach can be associated to many names in the literature, such as "progressive," "constructivist," or "student-centered" (p. 31). This approach emphasizes that students are able to construct meaning for themselves through strategies such as seat- and group-work or connecting the content with real context. The "student support" approach seeks to empower students and to increase their autonomy and self-confidence. In this approach, mastering the subject content is secondary.

Questioning framework: This framework emerged as a synthesis of frameworks that analyze interaction in mathematics classrooms (Nathan & Kim, 2009; Truxaw & DeFranco, 2008; Wells, 1993; Wells & Arauz 2006). With this framework we sought to characterize the opportunities that students have to express their thinking about doing mathematics and to contribute mathematics that is new to the class (Mesa & Lande, 2010) and we focused on questioning strategies. In particular we describe two types of questions, routine and novel. To answer a routine question (e.g., "what is the common denominator here"), students are expected to know the answer to or know how to procedurally figure out the answer. Novel questions (e.g., "under what conditions would the orbit [of the satellite] have been hyperbolic?") require the students to give an opinion or to connect different pieces of knowledge in order to provide an answer that is not already known. Novel questions represent opportunities for the students to engage in mathematical work and to obtain meaning of what they are learning.

We sought then to contrast instructors' declared approaches with their interaction in the classroom, in terms of the types of questions they asked and their non-mathematical discursive interactions. We anticipated seeing instructors distributed along the spectrum of teaching approaches, and expected to see an association between the types of questions and the declared teaching approaches, with teachers espousing a 'meaning-making' or a 'student support' focus

asking more novel questions, and with teachers espousing a more traditional approach asking more routine questions.

Results

Table 1 shows the comparison between the coding approaches and the percentage of instructor and student questions. The three first columns after the instructors' names represent the coding approaches drawn from the interviews. We considered an instructor holding one of the approaches when more than 10 percent of the codes fell in that category. As a result, we found four groups of instructors. In the first group are four instructors (Evan, Ernest, Emmet, and Elijah) that only hold a Traditional approach to teaching. In addition to a traditional approach, three instructors (Elliot, Edwina, and Elrod) exhibit a Meaning Making approach. A third group (Elizabeth, Edward, Earl, and Emily) holds all the three approaches. Finally, three instructors (Elena, Erin, and Erik) exhibit only Meaning Making and Student Support approaches, excluding a Traditional approach to teaching. Table 1 is organized from the more instructor-centered to the more student-centered instructors. The next three columns present the same three approaches but reflected in non-mathematical discursive interactions. So far, eight instructors have been coded. The shaded circles represent fifths of the relative proportion of the number of non-mathematical discursive interactions classified into one approach out of the total of discursive interactions coded for each instructor. For instance, in the case of Elrod, he exhibits 53% (40 to 59% range) of Traditional strategies, 29% of Meaning Making (20 to 39% range), and 18% of Student Support (0 to 19% range). These preliminary results show certain association between the declared approaches and the non-mathematical discursive interactions observed in the classrooms. Traditional instructors tended to use more traditional discursive interactions, such as following the book and covering the material, whereas instructors at the bottom of Table 1 used more Meaning Making and Student Support discursive interactions, such as making connection to real context and praising students.

Regarding classroom questioning, first, it is important to notice the large number of questions that instructors asked in these classrooms: on average instructors asked 90 questions per period (85 min long), with four instructors asking less than half of those per class. Other data (not included in Table 1) reveal that students ask 17 questions on average, which is consistent with a Traditional approach, in which the instructor holds the authority for managing interaction. From Table 1 we see a less clear pattern regarding the proportion of novel questions and instructors' declared approaches, although it appears that the Student Support group of instructors ask relatively fewer novel questions than instructors in the other groups.

In this preliminary analysis we found alignment between instructors' approaches to teaching derived from the interviews and their non-mathematical classroom discursive interactions, which was anticipated by the higher education literature. However, when looking at the proportions of novel questions asked, we do not see an association between the number of novel questions and the espoused teaching approaches. Our math education frameworks would have predicted larger proportions in the meaning making and student support categories. Our preliminary results hint at gaps in both traditions in analyzing instruction. For higher education researchers, instructors' espoused concepts and approaches to teaching are related to what instructors do in classroom, but they do not necessarily relate to mathematics content and mathematics learning opportunities. On the other hand, for mathematics researches is important to notice that although instructors' espoused theories might not be not related to mathematics content, they have an

effect in the classroom. To understand the extent to which these non-mathematical discursive interactions of instruction have an effect in college math education we require further research.

Table 1: Comparison between teaching approaches and classroom practices [a]

Instructor	Traditional	Meaning Making	Student Support	Traditional classroom[b]	Meaning Making classroom[b]	Student Support classroom[b]	Total Instructor Questions per class period[c]	Instructor Novel Questions[d]
Evan	X			n.a.	n.a.	n.a.	46	26%
Ernest	X			n.a.	n.a.	n.a.	99	27%
Emmet	X			◑	◔	○	44	33%
Elijah	X			◕	○	◔	90	12%
Elliot	X	X		n.a.	n.a.	n.a.	89	16%
Edwina	X	X		n.a.	n.a.	n.a.	17	12%
Elrod	X	X		◑	◔	○	109	43%
Elizabeth	X	X	X	n.a.	n.a.	n.a.	73	35%
Edward	X	X	X	n.a.	n.a.	n.a.	85	28%
Earl	X	X	X	◑	◔	○	123	21%
Emily	X	X	X	○	◔	◑	92	14%
Elena		X	X	◑	◔	◔	176	16%
Erin		X	X	○	◑	◔	148	18%
Erik		X	X	○	◔	◑	163	3%

○ 0-19% ◔ 20-39% ◑ 40-59% ◕ 60-79% ● 80-100%

Notes: a. Because some of the instructors were observed in more than three times, the percentages of questions were obtained from the average of the amount of questions that instructors asked during each observed period. b. These categories represent the percentage by fifths of non-mathematical discursive interactions in the observed classrooms. c. A class period corresponds to 85 minutes. d. These percentages represent the number of novel questions out of routine and novel questions asked by each instructor. n.a.: not available for this preliminary report.

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