STUDENT-CENTERED TEACHING PRACTICES IN KOREAN ELEMENTARY MATHEMATICS CLASSROOMS

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The current mathematics education reform requires substantial changes toward student-centered instruction. In contrast to the widespread awareness of the reform agenda, there is a concern that many teachers do not quite grasp the vision of the reform. This study explored the breakdown that may occur between teachers' adoption of reform objectives and their successful incorporation of reform ideals by comparing and contrasting two reform-oriented Korean classrooms. Given that the two classes established similar social participation patterns but different mathematical culture, this study highlights the importance of sociomathematical norms in the analysis of reform-oriented practices and discusses implications for reform at the classroom level.

BACKGROUND

Educational leaders have sought to change the prevailing teacher-centered pedagogy of mathematics to a student-centered pedagogy (NCTM, 1991, 2000). The term *teacher-centered* refers to a teacher's explanations and ideas constituting the focus of classroom mathematical practice, whereas the term *student-centered* refers to students' contributions and participations constituting the focus of classroom practice.

The reform movement has been successful in marshaling large-scale support for instructional innovation, and in enlisting the participation and allegiance of large numbers of mathematics teachers (Knapp, 1997). However, despite the widespread endorsement of reform, many teachers have not grasped the full implications of the reform ideals (Kirshner, 2002; Research Advisory Committee, 1997). Teachers too easily adopt new teaching techniques such as the use of real-world problems or cooperative learning, but without reconceptualizing how such an instructional change relates to fostering students' conceptual understanding or mathematical dispositions (Burrill, 1997). This is even for teachers who are committed to implementing reform recommendations (Fennema & Nelson, 1997; Pang, 2000). The real issue is then to understand not the form but the quality of an instructional method. What kinds of mathematical and social exchanges occur and in what ways such changes promote students' mathematical development?

Korean students have consistently demonstrated superior mathematics achievement in recent international comparisons (e.g., Beaton et al, 1996; Mullis et al, 2000). Despite the high performance, the problems in Korea with regard to mathematical education are perceived to be similar to those in other countries. Such problems include learning without deep understanding, negative mathematical disposition, weak problem solving ability, and lack of creative mathematical thinking. These shared problems mainly come form teacher-centered instruction in Korea (Kim et al, 1996), and broad-scale efforts have been launched to influence the ways mathematics is taught. The most recent 7th national

curriculum and concomitant textbooks and teachers' guidebooks consistently recommend student-centered teaching methods (Ministry of Education, 1997).

Given the challenges of implementing reform ideals, this study is to understand better the *processes* that constitute student-centered pedagogy in Korean elementary mathematics classrooms. However, this study makes a significant departure from previous research trends on reform where single reform-oriented classroom is extensively studied (e.g., Ball, 1993; Cobb & Bauersfeld, 1995). Close contrasts and comparisons of unequally successful student-centered classes have rarely been conducted in previous research on reform. Such comparisons can provide a unique opportunity to reflect on the subtle but important problems and issues of implementing educational reform at the classroom level.

This study probes in what ways the teacher and students create unequally successful student-centered mathematics classrooms and what kinds of learning opportunities arise for the students in these classrooms. This study then identifies the differences and similarities among the classrooms in order to gain insights on the challenges for reformers -- including educators, policymakers, administrators, and educational researchers -- in changing the culture of primary level mathematics instruction.

THEORETICAL FRAMEWORK

A general guideline to the understanding of mathematics teaching practices is an "emergent" theoretical framework Cobb and his colleagues developed that fits well with the reform agenda (Cobb & Bauersfeld, 1995). In this perspective, mathematical meanings are neither decided by the teacher in advance, nor discovered by students. Rather, they *emerge* in a continuous process of negotiation through social interaction.

Along with the emergent perspective, two constructs of *social norms* and *sociomathematical norms* are mainly used to characterize each mathematics classroom (Yackel & Cobb, 1996). General social norms are the characteristics that constitute the classroom participation structure. They include expectations, obligations, and roles adapted by classroom participants as well as gross patterns of classroom activity. For example, the general social norms in a student-centered classroom include the expectation that students invent, present, and justify their own solution methods and the role that teacher listens carefully to students' contributions and comments on or redescribes them for further discussion.

Sociomathematical norms are the more fine-grained aspects of these general social norms that relate specifically to mathematical discourse and activity. The differentiation of sociomathematical norms from general social norms is of great significant because interest is given to the ways of explicating and acting in mathematical practices that are embedded in classroom social structure. The examples of sociomathematical norms have included the norms of what count as an acceptable, a justifiable, an easy, a clear, a different, an efficient, an elegant, and a sophisticated explanation (Cobb, Gravemeijer, Yackel, McClain, & Whitenack, 1997; Yackel & Cobb, 1996). For instance, the sociomathematical norms in a student-centered classroom may include the expectation that students are to present their solution methods by describing actions on mathematical objects rather than simply accounting for calculational manipulations. Within this study, I

pursue the possibility that the breakdown between teachers' adoption of reform objectives, and their successful incorporation of reform ideals implicates the sociomathematical norms that become established in their classrooms.

METHOD

This study is an exploratory, qualitative, comparative case study (Yin, 1994) using *constant comparative analysis* (Glaser & Strauss, 1967; Strauss & Corbin, 1998) for which the primary data sources are classroom video recordings and transcripts. The data used in this paper are from a one-year project of reform in elementary schools in South Korea. As a kind of purposeful sampling, the classroom teaching practices of 15 elementary school teachers eager to align their teaching practices to reform were preliminary observed and analyzed. An open-ended interview with each teacher was conducted to investigate his or her beliefs on mathematics and its teaching.

Five classes from different schools were selected that aspired to student-centered classroom social norms. Two mathematics lessons per month in each of these classes were videotaped and transcribed. Individual interviews with the teachers were taken three times to trace their construction of their teaching approaches. These interviews were audiotaped and transcribed. Additional data included videotaped inquiry group meetings in which the participant teachers met once per month and discussed mathematics, curriculum, and pedagogy. Through the group meetings, the teachers had lots of opportunities to analyze their own teaching practices as well as others, which might help them develop a keen sense of what student-centered teaching practices look like at each classroom level. The interview and inquiry group data were to understand the successes and difficulties that might occur in the process of changing the culture of primary mathematics classrooms, as well as the recursive relationship among the teachers' learning, beliefs, and classroom teaching.

Data analyses have two stages: Individual analysis of each classroom and comparative analysis. Interview data were included in the analyses whenever they provided useful background information in relation to classroom teaching practices. Because case study should be based on the understanding of the case itself before addressing an issue or developing a theory (Stake, 1998), teaching practices are very carefully scrutinized in a bottom-up fashion using the four categories of classroom flow, the teacher's approaches, students' approaches, and students' learning opportunities. The central feature of these analyses is to compare and to contrast preliminary inferences with new incidents in subsequent data in order to determine if the initial conjectures are sustained throughout the data set.

Next, the data from the individual classes are employed for comparisons among the unequally successful reform instruction in terms of general social norms and sociomathematical norms. The difficulties and successes of the teachers were highlighted and the issues and obstacles that may point toward generic problems of reform were analyzed.

RESULTS

A preliminary analysis shows that the five classrooms display similar general social norms that are compatible with current reform recommendations (Ministry of Education,

1997; NCTM, 2000). For the purpose of this paper, however, the two among the five classes are compared and contrasted in terms of general social norms and sociomathematical norms in order to investigate the challenges of implementing student-centered teaching practices.

Comparison by General Social Norms

The two classes were 6th grade classes in different schools, and shared strikingly similar general social norms. There were many similarities with regard to the expectations, obligations, or roles adopted by the teacher and the students across the classrooms. Both classes displayed a classroom participation structure in which:

- The teacher and the students established permissive and open atmosphere so that students' ideas and even their mistakes were welcomed.
- The discussion pattern of social interaction predominated with a sequence of teacher-student turn taking.
- Each lesson consistently consisted of the brief review of the previous lesson, the teacher's introduction of new mathematical contents or activities, students' activities, and whole-class discussion.
- The teacher introduced mathematical contents in relation to real-life situations, and emphasized the process of problem solving.
- The teacher emphasized mathematical activity and utilized small group formats to encourage collaboration and discussion among students.
- The teacher encouraged students to find different solution methods for a given problem and to provide critiques of their peer's presentations.
- The teacher supported students' contributions to the discussion by providing praise and encouragement.
- Students solved problems for themselves and presented them to the whole class.
- Students complied with the teacher's instruction and usually listened carefully to their friend's explanations.
- Students collaborated with each other while working together.

The similarities in the general social norms exhibited within each class are not entirely coincidental. Korean reform centers around revision of the national mathematics curriculum and concomitant textbooks and teachers' guidebooks. Whereas educational leaders in Korea have recently attempted to provide for some degree of autonomy at a local school level, the reform documents are very influential leading to directive, coherent, and rather uniform changes. Given that the most recent textbooks and teachers' guidebooks provide detailed exemplary instructional procedures for each lesson, and almost all Korean teachers use them as the main instructional resources (Kim et al, 1996), the shared aspects of social norms per se may not be based on the teachers' own reflections on their lesson strategy.

Comparison by Sociomathematical Norms

Despite the exemplary *form* of student-centered instruction, the content and qualities of the teaching practices in the two classes were somewhat different in the extent to which

students' ideas become the center of mathematical discourse and activity. One teacher (Ms. Y) tended to focus on a pre-given mathematical idea after eliciting students' ideas, whereas the other teacher (Ms. K) consistently posed questions that further challenge and extend students' mathematical thinking after eliciting it.

For example, the two teachers taught the ratio of the circumference of a circle to its diameter by encouraging students to measure the circumferences and the diameters of various circular objects. Followed by students' measurement, Ms. Y hurried to emphasize the formula that the circumference of a circle divided by its diameter is about 3.14, and provided students with several problems to which they applied the formula. In contrast, Ms. K pushed students to explain and justify what they discovered through the activity, and filtered their multiple ideas to pursue mathematically significant ones. In particular, Ms. K posed questions by which students had to identify the variants and invariants as the sizes of circles vary.

A more subtle difference occurred when the two teachers taught a fundamental idea of permutations. With the reference to the mathematics workbook, the two teachers asked students to compare the case of electing two representatives and that of electing a president and a vice-president out of three candidates. In Ms. Y's class, students came up with 6 and 3 possibilities for the case of electing representatives, and Ms. Y initiated discussion by asking where the different answers resulted from.

Teacher: Where did the difference come from?

Yun-Jeong: One included the same choices, but the other didn't.

Teacher: So, what do you have to do to solve the first case?

Da-Hae: We should exclude the same choices.

Kwon-Min: I think we have to include the same choices. Because, if there are two students and one of the two is a president, then the other can't be a president.

Teacher: Do you think that the two cases [of the workbook] are the same?

Min-Gyu: No. The differences are … [pause]

Hae-Jin: I think the cases are different. The first case is to elect representatives, but the second is to elect a president and a vice-president.

Yun-Seok: In the first case, electing Young-Dae and Hyung-Ju are the same as electing Hyung-Ju and Young-Dae. In the second case, if Young-Dae is a president, then Hyung-Ju can be a vice-president, and vice versa.

Teacher: So, the cases are different. What do you have to do? How can you conclude?

Seong-Gyun: For the first case, you have to exclude the same choices, but for the second case, you have to include all the possibilities.

Teacher: So, there are three possibilities for the first case but six ones for the second case. Right? Let's move onto next activity.

In the episode, at first some students confused the case of permutations with that of combinations. The teacher asked them to focus on the difference of electing representatives and one president with one vice-president. Whereas Hae-Jin explained the cases themselves with little mathematical thinking, Yun-Seok came up with a clear idea

of the mathematical difference and justified his claim with specific examples. However, Ms. Y did not probe his mathematical thinking. Rather, she tended to reinforce what students had to do to get the right answer. As a subsequent activity, Ms. Y gave students a few complex problems only with permutations, and checked the answers at the end. Students had little opportunity to explore the mathematical difference in detail between permutation and combination.

In contrast, Ms. K carefully orchestrated the path of classroom discourse towards the mathematical distinction. After solving the problem of electing two representatives and one president with a vice-president out of three people, the students in Ms. K's class solved a similar problem but from five people. They then discussed when to consider the order of an arrangement of objects, and when not to do. When asked to explain what they had discovered by solving the two problems, students came up with the idea that the number of permutations divided by 2 is the number of combinations, that is to say, (3x2)/2=3 and (5x4)/2=10 respectively. With the excitement of this idea, Ms. K even encouraged students to explore whether this idea would work for the case of electing other numbers of people.

In summary, Ms. Y listened to students' various contributions but usually turned out to control the classroom discourse toward one direction – finding out the correct answer and following the sequence of activities per se rather than students' emergent ideas. This concern occurred across different classroom activities. The important sociomathematical norms of this class included mathematical accuracy and automaticity. In contrast, Ms. K carefully listened to students' individual or collective work and picked out mathematically significant contributions for subsequent in-depth discussion. The important sociomathematical norms of this class included mathematical insightfulness and difference. In this respect, the two classes developed a similar reasonable discourse structure, but students' learning opportunities are very much constrained by the mathematically significant distinctions embedded within the classroom discourse.

DISCUSSION

This study supports the growing realization of the reform community that reforming mathematics teaching involves reconceptualizing how students' engagement in the social fabric of the classroom may enable them to develop increasingly sophisticated ways of mathematical knowing, communicating, and valuing. The similarities and differences between Ms. Y's and Ms. K's teaching practices clearly shows that students' learning opportunities do arise not from general social norms, but from sociomathematical norms of a classroom community. This study addresses the need for a clear distinction between attending to the social practices of the classroom and attending to students' conceptual development within those social practices. In this respect, the construct of sociomathematical norms, not general social norms, should be focused for initiating and evaluating mathematics education reform efforts as they occur at the classroom level.

The teaching practices examined in this study also reveal that the simple dichotomy between student-centered and teacher-centered pedagogy obscures the variety of mathematics education reform possibilities. Ms. Y's class displayed student-centered instruction at one level. The general social norms established in Ms. Y's class, which

were compatible with reform recommendations, were very different from those norms in a typical teacher-centered mathematics class. However, the detailed analysis of the class illustrated that it displayed teacher-centered instruction at another level, because the ultimate focus of mathematical activity and discourse was on the teacher's methods.

Current reform emphasizes students' development with regard to both to specific mathematical content and to mathematical dispositions (Ministry of Education, 1997; NCTM, 2000). Stemming from Piaget's genetic epistemology, psychological constructivism provides valuable insights into the process of students' conceptual development. In order to understand students' mathematical enculturation, there has been increasing interest in theorizing learning mathematics as a social process (e.g., Seeger, Voigt, & Waschescio, 1998). However, the transition from students' conceptual development to its incorporation with social development has remained challenging. Ms. K's case supports one sort of coordination of social and psychological objectives via her explicit mediation of classroom discourse. In other words, the teacher masterfully attends to concordance between the social processes of the classroom and students' engagement toward development of specific mathematical concepts.

Implementing student-centered teaching practices is fundamentally about significant change, and the teacher remains the key to change. The extent to which significant change occurs depends a great deal on how the teacher comes to make sense of reform and respond to it. Teachers ne ed to be empowered in integrating different aspects of reform agenda with regard to their own diverse pedagogical motivations (Kirshner, 2002). To do so, we need to understand the difficulties or obstacles teachers may go through as they move on to student-centered instruction. This study with comparisons and contrasts between reform-oriented classes paves a way by which teachers and reformers open towards possibly subtle but crucial issues with regard to implementing reform agenda.

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