Journal of Pedagogy, Pluralism, and Practice

Volume 1 | Issue 2 Article 11

Fall 1997

# Making the Shifts: Three Middle School Teachers' Experiences in the Mathematics Education Reform Movement

Walter E. Stone Jr.

# Making the Shifts: Three Middle School Teachers' Experiences in the Mathematics Education Reform Movement

Walter E. Stone, Jr.

## Background

Since the publication of *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (National Research Council, 1989) and the *Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), teachers at all levels as well as high school mathematics teachers have been discussing and debating the vision of the *Standards* documents and endeavoring to make reforms or changes in their mathematics teaching practices. These reforms include teachers helping students develop mathematical power, that is, the ability to explore, conjecture, reason logically, to solve nonroutine problems, to communicate about and through mathematics, and to connect ideas within mathematics and other intellectual activity (National Council of Teachers of Mathematics, 1991). A question that arises from this debate is "what are teachers doing to make changes in their mathematics instruction since the publication of these documents?"

In order to address that question, I designed a small research project that centered around the question "What do you believe is effective mathematics teaching?" In asking this question, I wished to gather information that would contribute to knowledge about the mathematics education reform movement in the eyes of middle school mathematics teachers. I chose semi- structured interviews and classroom observations as the vehicles for inquiry. I wanted to learn how teachers talked about their teaching and also how they were translating their thoughts to working with students.

This study builds on the literature on teacher thinking and knowledge literature of Shulman (1987) which includes the thinking about pedagogical content knowledge. This study also looks at the development of a possible framework in looking at teacher change in mathematics. This framework comes from the "major shifts" in mathematics teaching practices as written in the *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991).

In these *Teaching Standards*, "major shifts" are presented that must occur in the practice of teaching mathematics so that teaching for the empowerment of students can occur. To teach mathematics effectively, classrooms must become mathematical communities, not

collections of individuals. Teachers must encourage students to use logic and mathematical evidence as verification, reason mathematically, conjecture, invent, and engage in problem solving, and connect mathematics with its ideas and applications. These ideas present a shift from students viewing the teacher as the sole authority for correct answers, that students memorize procedures, that students find answers in a mechanistic way, and that students view mathematics as a body of isolated concepts and procedures.

I pursued this research because I want to learn about how instruction is changing for our future undergraduate college students in which there is a group who will study to become teachers. The phenomenon of "teachers teach the way they are taught" has the potential to change as students are taught differently in school. This research also contributes to how professional development programs can produce shifts in teaching practices. Teacher education can be examined in a way that provides more information about how teachers and students can be better prepared to become effective teachers.

## Methodology

In an effort to understand the shifts that are occurring in middle school teachers' practices, during the Fall of 1993, I interviewed three middle school teachers about what they believed was effective mathematics teaching. As a follow up to the interviews, I observed a mathematics class taught by each teacher. Each interview was audio taped and field notes were recorded for each classroom observation. This data helped me answer the research question.

Each of the teachers were from the same urban school district. Two of the teachers were sixth grade teachers and one was an eighth grade teacher. All three of the teachers were teaching in regular education classrooms. These teachers were chosen because of their interest in the improvement of mathematics education in the district. This interest is known because of their participation in a project for the improvement of teaching mathematics offered by a mathematics education professor from a local university.

The research question, "What do teachers in an urban setting believe is effective mathematics teaching?" guided me through my interviews with teachers and observations of each of the teachers' classroom lessons. My interview questions often lead to asking the teachers to clarify their answers by giving explicit examples from their teaching experiences.

The "major shifts" outlined in the *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991) served as a framework to guide the design of the data collection. I relied primarily on the semi-structured interviews and observations as data collection strategies. All interviews were conversational in style with the purpose of allowing teachers to express their own personal views on effective mathematics teaching. I audio taped the interviews at each teachers' own school site and

transcribed the three interviews. The classroom observations followed within a week after each interview. The interviews were used to inform my observations to observe how each teacher's beliefs affect their practice.

The main research question was posed to learn about the "shifts" that are taking place in the teaching of middle school mathematics. With such a small sample of middle school teachers, it will be hard to make general statements about what is happening in middle school classrooms as a whole, but this study is one of many that is a start at looking for general trends in the practice of middle school teachers involved in the mathematics education reform movement.

# Findings

Findings from this study indicate that there are, in fact, "shifts" in practice as outlined in the *Teaching Standards*. It was found that responses to the main research question reflect the shifts away from mathematics classrooms as collections of individuals, and mathematics as isolated concepts and procedures, to mathematics classrooms as mathematical communities and mathematics as connecting ideas and applications. The shift of teacher as sole authority and student reliance on memorization of procedures toward logic and mathematical evidence as verification and mathematical reasoning was also observed. The teachers in this study also spoke about the shift in assessment activity from paper and pencil assessment to assessment aligned with instruction. These findings have the potential to have important implications in how teacher change can be examined and reported. Below are snapshots of findings from interviews and classroom observations.

## "It's Okay to Share": Mathematics Classrooms as Mathematical Communities

In reviewing the data, it was found that there was a shift from mathematics classrooms as collections of individuals to mathematics classrooms as communities of students. The teachers in this study reported that they felt that cooperative learning is a major factor in effective mathematics teaching. These teachers emphasized that during math time, "it's okay to share, it's okay to ask other students in your group to share their process in problem solving." In a classroom observation of students working on fraction computation problems, students worked in cooperative groups and shared their strategies and processes with their group and with the whole class. The class worked together at resolving any difficulties that students were having with the problems. The teacher asked group leaders to report group results and students had the responsibility of listening to each other and working as a community rather than a set of individuals.

## Mathematics as Connecting Ideas and Applications

A major theme that arose in teachers interview responses was making mathematics real

for their students, in other words, to connect mathematical ideas and applications to a student's life. From the classroom observations, one of the sixth grade teachers designed lessons around an activity about aquariums. In this activity, students were given a 30 gallon aquarium and $25 to spend on fish. Students brainstormed about their experiences with aquariums and what materials they would need to keep an aquarium. In solving the problem about what kind of fish to buy for the aquarium, students came up with questions about the types of food that fish eat, and what kinds of fish get along in the same aquarium. When asked what this activity has to do with mathematics, students spoke about measurements (gallons, cubic centimeters or inches, feet, teaspoon, pinch, degrees of temperature, water air pressure). The students also spoke at length about the type of problem solving this type of project needs. This discussion about problem solving showed the power the students had in "thinking about the thinking" or metacognitive skills needed to solve a problem they may have a chance to tackle in their lives. Students exclaimed that they would need a much larger budget so that they could feed the fish and decorate and clean the tank. Students were able to extend their thinking on the original problem of how much fish to buy to many other issues they felt should be under consideration.

## Students Gain Authority

The teachers spoke at length about needing to know what students were thinking about while engaged in mathematical investigations and activities. This allowed the teachers to gauge a student's mathematical authority. To do this, teachers designed lesson activities that allowed students to investigate mathematical situations and to talk about mathematics, thus allowing the teachers to assess student knowledge about their mathematical problem solving skills as well as how students verify their results and gain mathematical authority. During one lesson observation, students were using fraction factory pieces to show equivalence of fractions. While setting up examples of equivalent fractions with the pieces, students were able to verify on their own whether fractions were equivalent or not. When students had trouble with this activity, the teacher asked the student to show her how two fractions are equivalent using the fraction factory pieces. It was through this student investigation guided by the teacher that the student was able to gain authority through verification of a solution to a problem. In response to many of the students questions about the activity, the teacher often asked other students or groups of students to give examples of equivalent fractions, allowing the students to see examples made by other students. The teacher transferred authority of correctness of answers and verification of results to the students, not entirely to herself.

## Changes in Assessment Practice

I observed students in the classroom who were actively engaged in investigating mathematical problems and showing their mathematical power. Teachers in this study were aware of the potential of "learning while learning about what students were

learning." Teachers in this project were in the stage of learning about how to assess student knowledge that is aligned with instruction. Instead of reliance on paper and pencil quizzes and tests, the teachers in this study were working on incorporating ways of examining student progress while students are engaged in mathematical activities. One of the teachers observed that

I've learned much more through seeing students work together on mathematical tasks than I have seen on a conventional quiz or test. There is a dynamic there that I see much better when the students are working together on a task rather than when they are working alone in isolation.

As seen in the above examples, there are indeed shifts occurring in the practices in the teaching of middle school mathematics.

## Implications

The *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991) has provided a good framework to gather information about teaching practices. The interview and classroom observation data was easily coded along the lines of the shifts in practice. There is potential for this framework to be implemented in the observation and supervision of prospective teachers.

The findings of this study show that the mathematics reform movement is alive and well. The sixth grade students in the classrooms of the teachers interviewed in this study are now sophomores in high school. This means that students are coming to the undergraduate mathematics coursework prepared differently than those 'traditionally prepared.' Given this information, there needs to be more dialogue about what types of knowledge and dispositions students are bringing with them to the college experience. A new question arises about how to prepare teachers that have reformed experiences of how to teach mathematics.

# References

National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1991). *Professional Standards for Teaching Mathematics*. Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (1989). *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, DC: National Academy Press.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22. 1