Changing Teacher Roles: A Case Study

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Abstract

Case study research focusing on changing teacher roles associated with a grade six teacher's use of innovative mathematics materials is described. Daily observations and regular interviews with all participants provided a picture of professional growth and major influences on this process. The teacher demonstrated increasing comfort with posing non-routine problems to students and allowing them to struggle together. He also increasingly provided structured opportunities for student reflection upon activities and learning. Major influences on this teacher's professional growth are discussed.

Introduction

With increasing interest in curriculum and professional development programs designed to encourage teachers to reconceptualize their roles, two important needs have emerged in recent years. First, there is a need for clear descriptions of the role of teachers in such "reformed" classrooms. Second, there is a need for detailed descriptions of the process of teacher change, with an emphasis on those factors which are seen to exert an influence on that process. With these two aspects in mind, the major questions addressed by this study were the following:

1 In using a unit of work based largely on non-routine problems, in what ways does the role of the teacher change?

2 What factors influence the process by which the identified changes occur, and what is the nature of these influences?

The Teacher's Role in a Reformed Classroom

Prior to the study, a six-component categorization of the teacher's role in a reformed classroom was developed, drawing on seven projects or studies that had many features in common with the vision of mathematics education reform (Cobb, Wood, & Yackel, 1990; de Lange, van Reeuwijk, Burrill, & Romberg, in press; Fennema, Carpenter, & Peterson, 1989; Lampert, 1988a; Middle Grades Mathematics Project 1988; Schoenfeld, 1987; Stephens & Romberg, 1985). This categorization appears in Table 1.

The categorization provided a "conceptual framework" for the study (Eisenhart, 1991). It is not claimed that the six components are an exhaustive list, and not all of the studies placed equal emphasis on each aspect. However, the components did provide a useful framework for studying the role of the teacher in this study, and in particular the changes in this role. One consequence of this study was the augmentation of this framework by a seventh component, as discussed in a later section.

There is considerable evidence in the research literature that beliefs and practice are dialectically related, and the structure of the table reflects this relationship. It is also recognized that teachers can espouse certain beliefs not in harmony with observed practice (Ernest, 1989; Thompson, 1992).

Table 1: Components of the Role of the Teacher in a Reformed Classroom and Related Beliefs about the Teaching and Learning of Mathematics

Components of the Role (what the teacher does)	Related Beliefs About the Teaching and Learning of Mathematics
1. The use of non-routine problems as the starting-point and focus of instruction, without the provision of procedures for their solution	Students can solve non-routine problems without first being taught a procedure
2. The adaptation of materials and instruction according to local contexts and the teacher's knowledge of students' interests and needs	Mathematics needs to be studied in living contexts which are meaningful and relevant to students, including their languages, cultures, and everyday lives
3. The use of a variety of classroom organizational styles (individual, small-group, whole-class)	Differences in mathematical tasks and preferred learning styles of individuals demand variety in classroom organization
4. The development of a "mathematical discourse community," with the teacher as "fellow player" who values and builds upon students' solutions and methods	An atmosphere of conjecture and justification of mathematical ideas enhances learning Teachers should be open about their own struggles with mathematical problems Students' solutions and methods provide the basis of discussion of problems
5. The identification and focus on the big ideas of mathematics	Important mathematical ideas are not confined to specific procedures in isolated content areas, but rather mathematics is seen as an integrated whole, in which the processes of problem solving, reasoning, and communication are central
6. The use of informal assessment methods to inform instructional decisions	Observing and listening to students provides a "window" into their thinking which can be used to plan further instruction

Method

A case study approach was used in studying two grade six mathematics teachers, Ms Anne Bartlett and Mr Tim Martin, from a school in a midwestern United States town. (Only one teacher will be discussed in this paper.) The students represented a range of socio-economic levels, with minority students comprising around 22% of the school population. Grade level groups were separated into different areas of the school. Classrooms within a given grade level area were separated in part by moveable partitions, providing a feeling of connectedness.

The team of four grade six teachers met weekly (and at other times at their desks and "on the run") for joint planning of mathematics and other curriculum areas. Mathematics was "officially" taught in all four classrooms from around 8.30 to 9.15 each morning. All four taught mathematics, science, language arts, and computer studies in the morning, and had the afternoon free for joint planning.

The grade six mathematics lesson consisted usually of a five to ten minute "warm-up" session (involving mental arithmetic, word problems, or brief puzzles), and homework review, followed by the major activities for the day.

Mr Martin had taught at the school for around 20 years, mostly at grade six level. During the course of the study, Mr Martin participated in a four-session professional development program with thirty other teachers, part of which involved teaching a six-week unit of work consisting of non-routine problems built around the theme of the discovery of a bone belonging to a "mystery person".

The unit of work used in the study was one from the *Mathematics in Context* project, an NSF-funded curriculum development project, based at the University of Wisconsin—Madison (Romberg et al., 1991), and was titled "Mathematics, Measurement, and Me".

Data Collection

I observed Mr Martin in class on 36 occasions and also his participation in team meetings and inservice sessions, and interviewed him formally six times. We also had numerous informal discussions. Data were collected inside and outside classrooms in several phases over a period of seven months. These phases corresponded to a short period before teachers began the first *Mathematics in Context* unit, an intensive period of work during the teaching of the first unit, and further (but less intense) data collection during the time between the teaching of the first and second *Mathematics in Context* unit (around four weeks). During classroom observations, seated at the rear of either classroom, I used a laptop computer to take field notes. I would also move around the classroom, observing students' work more closely, and occasionally talking to teachers and students. Although observations and interviews were my primary data sources, various documents (mathematical and administrative) provided additional, useful data.

Data Analysis

From the first week of data collection, I coded all interview, observation, and memo data. I started with initial (external) codes, based on the components of the teacher's role and likely influences on the process identified in the research literature. I used the Macintosh software program, "Hyperqual" (Padilla, 1990) in the process of coding. Hyperqual enabled me to code electronically (or "tag" in Hyperqual terms) each segment of data (a line, a sentence, a paragraph, or more). This process led to what Goetz & LeCompte (1984) called "a primitive outline or system of classifications into which data are sorted initially" (p. 191). The size of these units was determined by the usefulness of the unit and the extent to which it "stood on its own"—that is, the extent to which it could be interpreted in the absence of other information. Many segments of data were coded in four or five different ways, reflecting the fact that a particular statement could relate to several themes of interest. These coded segments were then (electronically) placed in different "stacks". Hyperqual then enabled me to sort the stacks further, drawing out, for example, all references in The *Tim* stack to assessment, and creating a stack of these ("*Assessment—Tim*").

Results

Data which related to the six components of the teacher's role (from Table 1) were collected for each teacher. An additional component emerged during data analysis which was useful in discussing the work of Mr Martin in particular. Owing to space considerations, two of particular interest will now be discussed.

The use of non-routine problems as the starting-point and focus of instruction, without the provision of procedures for their solution.

In the time during which I observed Mr Martin prior to his involvement in the *Mathematics in Context* project, he had placed considerable emphasis on the importance of making the tasks that he presented as straightforward for students as possible. This was usually achieved by anticipating any difficulties students were likely to have, and either removing them or offering a procedure by which they could be overcome. This action on his part was later to be described by him as "short-circuiting" their thinking (Interview, 9/10/92).

The measurement unit seemed to be a "liberating experience" for Mr Martin. The major area of professional growth that I observed was in Mr Martin's increasing willingness to "step back" and let students struggle with problems, resisting the pressure to curtail mathematical exploration by the

provision of his method of solution. For Mr Martin, then, this component of the teacher's role became "to tell or not to tell."

This area of growth was confirmed by Mr Martin during numerous brief conversations and interviews (e.g., Field notes, 28/9/92, Interviews, 23/10/92, 23/11/92). He often referred to the constant desire that he felt to help students avoid difficulties by laying out a path for them, a desire that he increasingly resisted over the course of the measurement unit as he saw the power of the solutions that students could develop, even when given minimal guidance.

> *I am aware of that now, more so than before, of letting kids struggle with those decisions themselves rather than having me lay it out for them. I think what happens is I have part of my own feeling of success or failure related to whether I think kids are successful. So maybe I do too much to insure a certain sort of shallow success. If I have to hand it to them perhaps it's really not success, but it could be interpreted as that anyway. (Interview, 9/10/92)*

Discussions with Mr Martin over the course of the study indicated that he was seeing that students' successful struggle with challenging problems was more powerful than the shallow sort of success that he described above.

In using materials of this kind, one of the greatest (and possibly *the* greatest) challenge is for the teacher to avoid the temptation to "tell." This was a struggle that Mr Martin frequently referred to. Those responsible for professional development programs (whether in the form of inservice or within-class support) need to consider ways to address this with teachers. Few would argue that a teacher should never tell students about a concept or a procedure, but this study suggests that more discussion is needed in the mathematics education community about appropriate and inappropriate situations for "telling."

A seventh component of the teacher's role--the facilitation of student reflection on activity and learning.

In the time prior to and following the teaching of the measurement unit, Mr Martin seemed to spend only a small amount of time discussing the purpose of the day's mathematical activity. However, during the course of the measurement unit, Mr Martin increasingly took time to encourage students to reflect on their recent experiences (e.g., Field notes, 13/10/92, 15/10/92). Questions such as "why did I get you to do that activity today?", "What were you supposed to learn from creating that table?", and "Why would someone want to know their surface area anyway?" became more common as the unit proceeded.

We discussed several times (e.g., Interviews, 17/9/92, 9/10/92) the need that Mr Martin saw for the pace of classroom activity to slow down in order to give students a chance to think about what their activity and what they had learned:

> *I'm conscious of what went on the day before, or the week before even, and I attempt to bring that in because I get the feeling in my past . . . there can be this kind of busy stream of consciousness sort of phenomena, too. If I'm a kid and I'm sitting out there, it would seem to me like all these facts and activities are being run past me on 78 when I'm a $33\frac{1}{3}$ guy. (Interview, 17/9/92)*

Mr Martin used terms like "treadmill" (Interview, 9/10/92) and "roller coaster" (Field notes, 28/9/92) to describe the frantic pace at which grade 6 students moved from content area to content area during the school day, and he stressed the importance that he attached to slowing down the pace.

For most of the measurement unit, Mr Martin had the flexibility to extend the

mathematics lesson by up to 30 minutes. This extra time was used to either enable students to finish their group measuring or writing tasks, or to provide a kind of "debriefing" session on what had transpired on that day. This reflection time provided further opportunity for Mr Martin to see the quality of student work on the assigned tasks.

Factors That Influenced The Process Of Changing Roles

Drawing on coded data from interviews with Mr Martin, other teachers, school administrators, and project staff, together with observations, I identified 12 factors that appeared to influence the process of changing teacher roles. Each factor is included because statements made by the teachers themselves or other "players" in the study pointed to the influence of the particular factor. Not surprisingly the extent and kind of influence varied across influences and across teachers. The twelve factors were:

1 The reform movement in general

2 The principal and school community

3 Internal support personnel

4 The spirit of collegiality, collaboration, and experimentation

5 The grade level team of teachers

6 Innovative curriculum materials

7 The inservice program

8 External support personnel

9 The researcher as audience and critical friend

10 Outcomes valued by the teacher

11 Day-to-day conditions under which teachers work

12 Teacher knowledge

Few items on this list would come as a surprise to those experienced in the professional development of mathematics teachers. I will therefore discuss only two of these. It is very easy to write about impediments to professional growth, and the literature abounds in them. I have chosen two which were seen by all participants as positive influences on Mr Martin's professional growth.

Innovative Curriculum Materials

In the case of Mr Martin, based on observations and his comments during interviews, it would seem that students' work on the measurement unit did create or strengthen a belief that students can succeed in learning important mathematics when posed problems for which no previously-taught procedure for solution is available. Mr Martin believed the unit to be the ideal "vehicle" for enacting his beliefs of what a mathematics classroom should be like (Interview, 9/10/92).

Wood, Cobb, and Yackel (1990) identified the provision of innovative curriculum materials and the opportunity for reflection on students' work with them as major factors in teachers finding their previous practice problematic. The unit seemed to have this effect on Mr Martin in the area of "telling" and in the area of assessment. Would the same professional growth have been evident without the provision of curriculum materials, as CGI identified in elementary schools (Fennema et al., 1989)? Data from this study of course cannot provide a sure answer to this question.

The Researcher as Audience and Critical Friend

In this study, I had expected to take the role of participant observer in the classroom, and exert a minimal influence. In Mr Martin's class, there were many occasions when he would come across to me (whether I was sitting at the back of the room typing field notes or moving around the room looking at students' work), and share a comment or an observation on a student's solution, the way in which he had just presented some content, or the work of the class in general. He seemed eager to talk about these things, and this seemed a most valuable form of support to him during the teaching of the unit. He also frequently looked quickly across at

me for a reaction during whole class discussions, particularly when an individual student demonstrated particular insight. It seemed inappropriate to ignore these "looks," and I have little doubt that a smile in these circumstances served as an encouragement to him.

Thompson (1992) claimed that the extent to which experienced teachers' beliefs about the learning of mathematics are consistent with their classroom practice depends largely on their tendency to reflect on their actions. I found that my conversations with Mr Martin provided this opportunity for reflection, and much of the discussion revolved around reconciling what he was observing as he stood back and allowed students to struggle, with what he had previously believed about the need to "lay things out" for students. In the case of Mr Martin, Thompson's claim was verified. Perhaps Thompson's statement could be extended to say that consistency between teachers' beliefs and practice depends largely on their tendency *and opportunity* to reflect on their actions.

Conclusion

This study provided some insights into the struggles, challenges, and highlights as teachers attempt to use innovative materials. It enabled a description of their changing roles and the many influences that impact on the process of professional growth. It highlighted the difficulty of change as teachers wrestle with the notions of reconceptualized roles, but it also showed that change can occur, if those factors which facilitate teachers' professional growth are in place.

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