Reading Instruction in the Middle School Mathematics Classroom

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Since the 1989 publication of the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics, it has been increasingly common for mathematics teachers to incorporate some aspects of reading into their classes. The purpose of this study was to determine the amount and type of reading instruction occurring in selected middle school mathematics classrooms. Through this research, we hope to (a) give mathematics teachers some insight into the reading instruction that occurs in their classrooms, (b) help them reflect on how well they integrate reading instruction into the teaching of mathematics, and (c) provide them with suggestions for possible instructional adjustments.

Studies in other disciplines suggest that altering text materials and integrating reading instruction with content instruction leads to greater mastery of both (Horak, 1985; Holbrook, 1984; Seeber, 1984; Weinstein & Mayer, 1986). We know, for example, how to alter textbooks to make them more appropriate and we know how to help students use textbooks to better learn content. We also know that prereading strategies–especially when related to text organization, content schemata, and unfamiliar vocabulary–increase student achievement.

Despite this growing body of research, the most recent *Handbook of Research on Mathematics Teaching and Learning* (Grouws, 1992) does not include references to this topic. However, the *University of Chicago School Mathematics Project* (Usiskin, 1990) materials help mathematics teachers infuse more reading and writing into grades 7 to 12 mathematics classrooms. In addition, a growing number of journal articles and reports provide mathematics teachers with help teaching students to read and comprehend story problems, identify difficulties encountered in reading mathematics, and other specific and practical techniques, activities, and strategies to overcome these reading difficulties (Davis & Gerber, 1994; Hall, 1984; Kirsch & Mosenthal, 1993; Mann & Frame, 1989; Mosenthal & Kirsh, 1993). Winograd (1994) has even provided a bibliography for mathematics teachers interested in interdisciplinary efforts. Moreover, recent reports document many new cross-curricular initiatives for middle school and high school mathematics teachers (Beaupre, 1992; Bravo, 1994; Davis, 1993; Spanos, 1990; Center for Applied Linguistics, 1993).

Method

Subjects

Eleven midwestern, urban, middle school mathematics teachers were identified upon the recommendations of the county mathematics coordinator. Of that 11, 6 volunteered to be part of this study. These six teachers had extensive teaching experience: three had over 20 years of teaching experience, one had 19 years experience, and the others had 8 and 10 respectively. The teachers taught in the middle grades, 5 through 8. Four of the teachers worked in urban settings and two taught in suburban settings. The classrooms observed represented a diverse mix ofAfrican American, urban Appalachian, and other white students. In most respects, these teachers would be considered "typical." The videotaped instruction could easily have come from the majority of classrooms in this country. The findings are not based on ideal settings, but rather on the realities of urban classrooms.

Evidence from the National Assessment of Educational Progress (Educational Testing Service, 1992) suggests that most mathematics instruction is "traditional" rather than "innovative." Though mathematics teachers report using materials and approaches endorsed by such documents as the NCTM Standards (1989), students report their experiences in mathematics classrooms to be very different from what research suggests to be effective. Findings from the most recent NAEP report suggests that there is still an emphasis on computation exercises to teach mathematics. The subjects in our study, reflecting a growing trend, used manipulatives to illustrate mathematics concepts or teach a particular skill. However, the majority of classroom time was spent on computational exercises. This study examines how reading instruction occurs in such mathematics classrooms.

Observation Instruments

The instrument, validated by reading experts across the country, was a continuous time device designed to account for time devoted to (a) content reading instruction, (b) content instruction using activities other than reading, and (c) non-instruction. These categories are described in detail below. This instrument was chosen for a variety of reasons. It has been used in several other studies (Bullock, Laine, & Slinger, 1990; Hesse, Bullock, & Villalovoz, 1982; Slinger, 1981) and provides an opportunity for comparisons between the use of reading during mathematics instruction and during instruction in other subject disciplines.

Content Reading Instruction. Content area reading instruction is defined in this study as teaching that helps students with reading and understanding assigned materials in mathematics. In order to more adequately assess this type of teaching, this study divided content reading instruction into three types–passive, active, and oblique–each determined by the degree of interaction among teachers, students, and materials. The types of reading activities are described below.

Active Reading Instruction. Active reading instruction includes activities where there is an observable interaction among the teacher, students, and the reading assignment. This instruction is characterized by the teacher engaging students in how to read the material either prior to or during the actual reading of the assigned material. Typical examples of this kind of instruction are teachers preteaching vocabulary that will be encountered in an assignment, setting a purpose for the reading, or providing strategies for reading tables, charts, and graphs that appear in the assignment.

Passive Reading Instruction. Passive reading instruction describes situations in which students attempt to read assignments on their own without any prior teacher direction. An example of this type of reading instruction is when students, upon arrival in class, find only the reading assignment on the chalkboard. Although there is an observable interaction between students and texts, the teacher is uninvolved.

Oblique Reading Instruction. Oblique reading instruction, which lies between active and passive on this continuum, involves interactions between the students and the teachers; however, the instruction does not directly assist students in reading the assignment. Teaching a reading skill without relating it to a specific reading assignment is typical of this type of instruction (e.g., teaching students how to read charts or tables without relating it to a particular text assignment). Essentially, the teacher is teaching reading out of the context of the mathematics assignment.

Nonreading Content Instruction. Nonreading content instruction includes situations when instructional activities and strategies other than reading are used by the teacher and the students. Examples of these activities include lectures, demonstrations, laboratories, discussions, debates, and film.

Noninstruction. Noninstruction involves no teaching whatsoever. Examples of noninstruction include taking attendance, making announcements, listening to interruptions on the public address system, interacting with visitors to the room, giving students free time, and interrupting and chastising students.

Observation Procedure

The number of observations ranged from two to four class periods per teacher, for a total of 16 observations. The average observation was 49 minutes in duration. Two teachers were observed twice, one was observed three times, and one was observed four times. Fourteen class periods were observed for a total of 13 hours (780 minutes). A trained video technician entered the classrooms before classes started and videotaped the entire lesson. Multiple observations of the same classroom were designed to capture different points during the sequence of a teaching unit (i.e., from the introduction of a topic to the final instruction on that strand). This assured the best chance to capture whatever reading instruction might occur in a given classroom.

Reliability

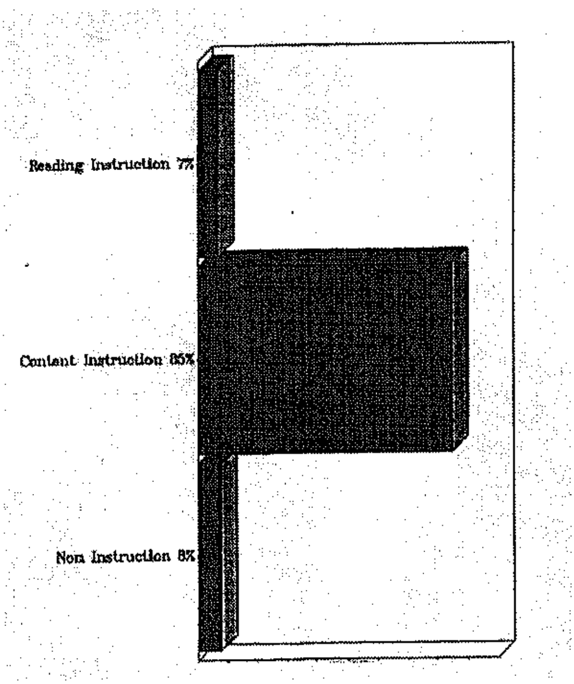
Slinger (1981) developed the continuous time instrument and provided the rater training in all previous studies. Interrater reliability ranged from .85 to 1.0 across the six studies and was .85 in this study of mathematics teachers. Since each session in this study was videotaped, Slinger first previewed all the tapes, then viewed each tape two more times, and coded the data twice. There was a 95% agreement between the first and second viewing of the videotapes. This slight discrepancy in ratings between the first and second viewing of the tapes can be attributed to picking up some additional information about a teacher-student interaction or some further insight about what was being presented by the teacher.

Results

Figure 1 summarizes the percentage of classroom time spent in each of the three main categories: reading instruction (active, passive, and oblique), Nonreading content instruction, and noninstruction in the mathematics classrooms. In the typical class period, 85% of the classroom time was spent on nonreading content instruction. Some form of content reading instruction accounted for 7% of the classroom time and the remaining 8% of the classroom time involved no classroom instruction (noninstruction).

Figure 1

Percentage of Classroom Time Spent in Three Main Categories



Active Reading Instruction

Teachers spent an average of 6% of the classroom time engaged in active reading instruction, that is, in activities where interactions among the teacher, students, and reading assignment were seen. The teachers were either preparing students for reading assignments or working directly with them while they read. "Preteaching vocabulary" was the primary example of active reading instruction. The teaching of vocabulary consisted of brief explanations of the words in the lesson. These explanations were not coded as "reading" if they were presented orally, without some written context. Sometimes the teacher would point out the word in the book or study sheet or write the word on the overhead. In nearly every case, the teacher provided a brief definition of the word. In one class, students were keeping a notebook of mathematics terms, so every entry during the class was coded as "preteaching vocabulary."

Passive and Oblique Reading Instruction

Passive reading instruction (where students read silently, without teacher interaction) accounted for .03% of the classroom time, while oblique reading instruction (teaching a reading skill without relating it to a specific text) made up 1.05% of the classroom time. Under the oblique reading instruction category, the majority of the classroom time involved reviewing and assessing reading.

Nonreading Content Instruction

Nonreading content instruction was observed about 85% of the classroom time. Nonreading content instruction, which was viewed in all classrooms, included showing filmstrips, giving lectures, doing demonstrations, completing computational exercises, using manipulatives to illustrate mathematical concepts, conducting discussions, performing laboratory experiments, and showing films.

Noninstruction

In this study, only 8% of the classroom time was spent in noninstructional activities. Although there was not much classroom time coded as "noninstructional," there were periods of classroom time where the noise level in the classroom seemed to make it difficult for students to keep on task. Prior studies in other disciplines (Bullock, et al. 1990; Laine, Bullock, & Ford, in press; Slinger, 1981) found noninstructional time was typically in the 15% to 50% range.

Comparison of Content Areas

To date, five studies have been conducted examining the amount of reading, content instruction, and noninstruction that occurs in a variety of content area classrooms. A comparison of these findings appear in

Table 1
Types of Instruction Across Disciplines

Content Disciplines	Average Percentage of Classroom Time Devoted to Specific Types of Instruction				
	Nonreading Content Instruction	Noninstruction	Active Reading Instruction	Passive Reading Instruction	Oblique Reading Instruction
Language Arts & Social Studies (Slinger, 1981)	34	15	6	28	12
Language Arts Classrooms (Hesse, Bullock, & Villalovoz, 1982)	57	22	10	2	9
Reading Classrooms (Hesse, Bullock, & Villalovoz, 1982)	0	7	51	0	42
Social Studies & Language Arts (Bullock, Laine & Slinger, 1990)	20	15	15	15	35
Science (Laine, Bullock & Ford, in press)	24	20	16	7	33
Mathematics (Laine, Bullock & Drake, 1996)	85	8	6	.03	1.05

Table 1. The first study, conducted by Slinger (1981), looked at language arts and social studies classrooms. These were back-to-back classrooms where one teacher taught both classes. This initial study produced the following results: 51% reading instruction, 34% content instruction, and 15% noninstruction.

The second study, conducted in 1982, was actually two studies in one. In the language arts classrooms, reading took place 21% of the time, while content instruction and noninstruction accounted for 57% and 22% of the time respectively. The study also examined reading classrooms to see what kind of results would be obtained. As would be expected, 93% of the time was spent on reading instruction while 0% and 7% were spent on content instruction and noninstruction.

The third study (Bullock et al., 1990) once again examined English and social studies classrooms. This time the amount of reading instruction occurred approximately two-thirds of the time verses one-half of the time in the former study. Content instruction in this 1990 study accounted for one-fifth of the time compared to one-third of the time in the earlier study. In both studies, non-instruction occurred 15% of the time. The fourth study (Laine et al., in press) looked at reading in science classrooms. This particular study was similar to the first and third studies. Reading occurred over one-half the time, content instruction one-fourth of the time, and noninstruction one-fifth of the time.

The fifth and final study looked at mathematics classrooms. This study most closely parallels the examination of reading classrooms in the second study. In the mathematics classrooms, content instruction accounted for 85% of the classroom time, while in the reading classrooms, 93% of the time was spent on reading instruction. The mathematics teachers that we observed do not rely on reading as a mode of instruction but rather showed students how to go about solving problems by demonstrating specific techniques to the students.

Discussion

Our observations of middle school mathematics classrooms indicated that 92% of the classroom time was spent in teacher directed activities. Again, teacher directed activities included active reading instruction (6%), oblique reading instruction (1%), and nonreading content instruction (85%). This research found a significantly greater percentage of classroom time devoted to nonreading content instruction than was found in prior studies of social studies, science, and English classrooms (Bullock et al., 1990: Laine et al., in press; Slinger, 1981).

The other two classifications–passive reading instruction and noninstruction–accounted for 8% of the remaining classroom time. This 8% figure is much lower than the percentage cited in earlier studies. In fact, passive reading instruction by mathematics teachers accounted for less than 1% of the classroom time. In social studies, science, and English classrooms, 22% of the classroom time was devoted to passive reading instruction.

This study of reading in middle school mathematics classrooms revealed some additional interesting findings. First, 85% of the classroom time was spent on nonreading content instruction. Although our instrument does not break down this category into specific areas, this would be a very useful analysis to undertake in a future study. Second, 8% of the classroom time was spent on noninstructional activities. This meant that there was very little classroom time "wasted" in these mathematics classrooms. In other words, students in these classrooms were engaged in learning activities 92% of the time. Third, just slightly over 1% of the classroom time was spent on oblique and passive reading instruction, while 6% of the classroom time was spent on active reading instruction. When these mathematics teachers used reading instruction, they were working hand-in-hand with their students in order to read or understand concepts in the text.

Implications and Conclusions

This study demonstrates that these six experienced mathematics teachers do not generally employ the content reading strategies (active reading instruction) advocated by reading professionals. This may be due to misconceptions about content area reading instruction. Several sources (e.g., O'Brien & Stewart, 1990; Ratekin, Simpson, Alvermann, & Dishner, 1985; Readence, Bean, & Baldwin, 1989; Vacca & Vacca, 1989) found that teachers in many disciplines hold such misconceptions. For example, content teachers often feel that "reading" instruction is not their responsibility; all children should have mastered basic reading skills upon leaving elementary school. Some also feel that, as content specialists, prereading activities and guided reading activities take too much time–time taken away from content instruction. These secondary teachers believe that textbook authors provide adequate guidance and that prereading preparation is either unimportant or unnecessary. Finally, some content teachers reject reading strategies, arguing that they are not generalizable to their particular discipline.

The mathematics teachers in this study may reflect this orientation. Clearly, they devoted more time to nonreading content instruction than to using reading to teach mathematics. Reading may not be perceived as a prerequisite for learning mathematics. Misconstruing the advice of reading professionals, many contemporary mathematics teachers prefer to create environments where students actually "do" mathematics rather than use texts to teach mathematics in a rote manner. "Doing" mathematics, in other words, is preferable to "reading" mathematics.

Given the results of this study, an interesting question emerges: How can reading lead to better mathematics instruction? Mathematics instruction should be active, not passive. Science, English, and social studies are often textbook driven (Bullock, et al., 1990; Holliday, Helgeson, Blosser, & McQuire, 1985) and reading is often a preorganizer for content instruction in these disciplines. In contrast, in most traditional mathematics classrooms, independent reading is relatively rare and mathematics teachers do not rate the teaching of reading strategies as a high priority (O'Rourke, 1980). Prereading is not usually a technique used by mathematics teachers. In addition, most mathematics textbooks are not designed with this strategy in mind. Virtually all mathematics textbooks provide an explication of the computational process. Increasingly, textbook series, such as the one created by the *University of Chicago School Mathematics Project*, provide for some prereading. However, regardless of the textbook used, the effective mathematics teachers that we observed frequently used activities, demonstrations, and projects to create actual real world frameworks. The instructional time (actual reading instruction and nonreading content instruction) was used to help students learn concepts and vocabulary through listening, viewing, or reading. The teachers in this study, like many effective mathematics teachers, employed "hand-on" or "mind-on" mathematics. Whether through reading or some other method, computation, vocabulary, and mathematical concepts were introduced after discovery and exploration of a mathematical phenomenon.

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