Technical Report No. 544

HOW AMERICAN TEACHERS TEACH SCIENCE IN KINDERGARTEN AND FIRST GRADE

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TECHNICAL REPORTS

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December 1991

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The work upon which this publication was based was supported in part by the Office of Educational Research and Improvement under Cooperative Agreement No. G0087-C1001-90 with the Reading Research and Education Center. The publication does not necessarily reflect the views of the agency supporting the research.

1991-92 Editorial Advisory Board

Abstract

Nine full-day observations were made of 27 kindergarten classes and of 18 first-grade classes to discover how and how much science is being taught in these classrooms. The amount of time spent in science activities and the types of teachers' interactions during these activities were recorded. Kindergarten teachers were found to average from 0 to 28 minutes teaching science, while first-grade teachers averaged from 1 to more than 15 minutes of science instruction during a typical day. Analyses of the teacher-directed interactions revealed that about 40% of the interactions involved questions to be answered from children's background knowledge, over 25% were procedural, 11% were reviews of material presented previously, 7.5% were answered in texts, and 4% were oral reading turns. No significant differences were found among teachers in children's performance on a standardized test, whereas significant differences among teachers were found in children's performance on the three tests designed specifically for the study.

HOW AMERICAN TEACHERS TEACH SCIENCE IN KINDERGARTEN AND FIRST GRADE

> *Not even H. E. Armstrong, in his famous 1898 report, believed that children could find out everything for themselves. He recognized the mediating role of the teacher in structuring the environment and selecting resources. A teacher is making profound value judgments when . . . she contrives within the school environment for children's learning.* (Conran, 1983, p. 24)

Startled to find that the Soviet Union had launched Sputnik, American scientists and science educators three decades ago began to blame America's shortcomings in science and technology on the way children were being taught science in our elementary schools. They claimed that if teachers would put away science textbooks and focus upon "hands-on" activities, children would learn more science and would like it better as well. Millions of dollars later, several new approaches were available for teaching science in the elementary grades, and even more money was spent to get the programs implemented. However, as Mechling and Oliver (1983) observed: "What was intended to be a joyful discovery for students too often turned out to be a lost sojourn into the abstract and difficult" (p. 43). In short, these hands-on approaches failed.

Is history about to repeat itself? While the threat that the Russians are coming is becoming just a memory, our nation is now concerned about the economic threat posed by the Japanese and their advanced technological know-how. And, once again, science educators are raising the cry for teachers to rely less on textbooks and more on hands-on activities to develop scientific and technological literacy in American children (see Gough, 1990).

We hypothesize that one of the reasons that the last overhaul of science teaching in American schools failed is because no research had been conducted to see how elementary school teachers were actually teaching. Instead, science researchers and educators tried to make dramatic changes in the status quo without really knowing what that was. They simply assumed that textbooks were the culprits and that hands-on activities would be the saviours. We argue that we are much more likely to be able to make lasting changes in science teaching if we first conduct research that informs us about current practices and outcomes of science teaching.

For eight years, we have been conducting a longitudinal study of how children are taught science in American schools. We have used the first two parts of what Rosenshine and Furst (1973) describe as a descriptive, correlational, experimental loop. We have collected descriptive data on the entering ability, home backgrounds, schooling, home support for science learning, and ability at the end of each academic year for approximately 650 children from three school districts in two age cohorts, one year apart. We have then correlated all of these variables. Ultimately, we will develop models to explain science learning in each of the three school districts from kindergarten through sixth grade.

In this report, we use the kindergarten and first-grade school data we have gathered to answer the following questions:

1. How much time do kindergarten and first-grade teachers spend teaching science?

2. How do they interact with students during that time?

3. What is typical end-of-year student performance on standardized and customized tests?

We believe that informed answers to these questions will allow us to describe the general state of science teaching in America and guide us toward changes that both will improve science instruction in our schools and be accepted by teachers.

Related Research

In the early elementary grades, teachers usually place the most instructional emphasis on reading, then on arithmetic. Science typically receives very little emphasis. Research suggests that this is because teachers feel prepared to teach reading and arithmetic--but not science. In addition, both reading and arithmetic instruction are guided by the abundance of available published materials. It is well established that basal readers, workbooks, and ditto masters have a major influence on what is taught in reading (Anderson, Hiebert, Scott, & Wilkinson, 1985), and that teachers take time to cover what is in these materials (Barr & Sadow, 1989). This is also true for arithmetic instruction, although Porter (1978) has shown that teachers rarely cover *all* the topics in elementary school arithmetic books, and that the amount of time devoted to particular topics varies substantially from teacher to teacher.

No similar research has been published on science instruction in the early elementary grades, however, our analyses lead us to believe that the coverage of topics in science textbooks might be even less systematic and more variable from teacher to teacher. Indeed, in science, we believe that it would not be safe to assume that any time is spent on a given topic just because it is included in the text. Nor would it be safe to assume that there is uniformity among teachers in total time spent teaching science. It is doubtful that there is even much uniformity in topic coverage for teachers using a common textbook.

Time allocated for instruction may be thought of as simply an umbrella. The allocation of adequate time to teach a subject is necessary but insufficient in and of itself to guarantee that good instruction will take place. It is, however, closely linked to Carroll's (1963) concept of opportunity to learn. If teachers fail to allocate substantial periods of time regularly to a subject, children do not have opportunities to learn about that subject. It is only after teachers have allocated adequate amounts of time for instruction to take place that it is important to look further to see what teachers are doing with that time.

The last decade has seen substantial research on teacher effectiveness (Brophy & Good, 1986; Good, 1983; Rosenshine & Stevens, 1984), although the work has been done primarily in reading and math. Science is relatively unexplored territory. Much of the completed correlational and experimental research has converged on what Rosenshine and Stevens (1984) identify as "indices of instructional effectiveness." Academic engaged time, content covered, and student success rate are these three indices. Each of these is best thought of as a consequence of instruction, and each has been found to be strongly related to gains in student behavior. Several studies have focused upon time teachers spend teaching literacy-related activities. For example, Stallings and Kaskowitz (1974) found students in the highest performing Follow Through programs spent about 50% more time on reading or reading-related activities than did students in other programs. Similar results were found by Fisher et al. (1978), who observed reading and mathematics in second- and fifth-grade classrooms.

We believe that our study fills a void because most current work in science focuses upon students' misconceptions of scientific principles (Champagne & Klopfer, 1991), characteristics of science textbooks (Gilbert, 1989; Strube, 1989), or instructional computer packages (Hofmeister, Engelmann, & Carnine, 1989; Wainwright, 1989). In our study, we illustrate how science is being taught today in kindergarten and first grade and present findings from several new as well as traditional assessment measures.

Method

The Setting

Three school districts in the midwest participated in this research. Each of the districts has been described extensively elsewhere (Meyer, Wardrop, & Hastings, 1990). Therefore, the description that follows is brief.

District A is a small town about 45 minutes from a larger university town. Many of the parents in this community either farm or operate small businesses. The district has a reputation for high student performance in reading and average student performance in science. Community support is very strong for the early childhood programs in this school. Any school event typically finds 1,000 or more people in attendance, although there are only about 90 children per grade level in the district. There is one elementary school in District A, with four classes per grade level.

District B students live in a community less than half an hour from a much larger university town. Subsequently, many of the parents of children in this school district have a short commute to work. The parents here tend to have slightly higher economic status positions than do parents from District A. In addition, mothers from this district work fewer hours each week than do District A mothers. This district has a reputation for above-average student achievement in science in the early elementary grades. All children at each grade level attend the same elementary school. There were 7 kindergartens for Cohort 1 and 6 kindergartens for Cohort 2 students. In the period of data collection for this study, the district changed its instructional science program when it adopted a new textbook for science, offered science workshops to teachers, and appointed science coordinating teachers at each grade level.

District C represents yet another type of setting. Children from just 1 of 10 elementary schools in this large district participate in the study. There are three classes per grade level. First graders are grouped with second graders on teams for science instruction. White, Black, and Hispanic families make up this population, which is frequently referred to as a "microcosm of the universe." Parents in this school district range in background from single-parent domestic hourly employees to two-career professionals. This district is located in a suburb of a major city. For some families, life here may represent their first move from an inner-city environment. This community also includes wealthy, established suburbanites who are often the employers of the school district's domestic workers.

The Observation System

We conducted observations in 27 kindergarten and 18 first-grade classrooms to determine how teachers spend their time. The observation system we used was built upon the work of Stallings and Kaskowitz (1974), Fisher et al. (1978), and Barr and Dreeben with Wiratchai (1983). It is extensively described in Meyer, Linn, Mayberry, and Hastings (1985). Our goal was to be able to observe each child in every classroom for several full school days while keeping track of the amount of time teachers allocated to different activities. Time for an activity was recorded as the teacher announced the subject. It continued until the teacher signaled that the children were to stop doing what they were doing and move to a new activity. We also wanted to record the actual interactions teachers had with their students and to be able to code these interactions on the basis of the task that they required. For example, if a teacher said "Tell me the parts of this plant," while pointing to a marigold in a flower pot, the kind of task required of the students is unclear. Is this the first time the teacher has asked about the parts of a plant? Has the class been studying plants in their textbooks? Did the class study plants eight weeks ago thereby making this a review task? In other words, what kind of task is this? Are the children to answer from information stored in their heads--therefore, from their background knowledge? Was the information explicitly or implicitly presented in their textbook? Our observation system was designed to allow us to be able to code these different kinds of tasks.

The system was also set up so that we could determine with whom the interaction occurred. Did the teacher intend for the entire class, a small group, or an individual to answer the question? We changed the observation techniques when the teacher shifted to work with less than the entire class. When this shift occurred, we "swept" the classroom every 5 minutes to determine the percentage of children who were on task. A child was coded as being on task if he or she was doing whatever the teacher had assigned. Therefore, in kindergarten, if children were in free activity time, play was recorded as being on task.

Interrater reliability was checked during observer training and periodically during each school year. The agreement rates for the times, categorization of activities and interactions have consistently been .85 or higher. In addition, each teacher was observed by at least two persons each school year.

Results

The results summarized here are based on nine rounds of observations of nine kindergarten teachers for the 14 classes of children in Cohort 1, nine rounds of all but one of those same kindergarten teachers in 13 classes of children in Cohort 2, and nine rounds of observations of 18 first-grade teachers for Cohort 1. We will focus on the amount of instructional time teachers devoted to science activities and the nature of the interactions they had with students during this time.

Time Spent

Cohort 1, kindergarten. The likelihood that a child in one of these kindergarten classes will be exposed to any instruction in science on a given day depends on the child's teacher and on whether the child is in Cohort 1 or 2. During the first year of the study, science-related activities were observed on a total of only 10 of the 126 days of observation in the 14 classrooms. As Table 1 shows, the number of days in which time was spent on a science topic ranged from 0 to 3. District C children were most likely to encounter some science, but the likelihood in all three districts was dependent on the teacher that the child happened to have.

[Insert Table 1 about here.]

The average number of minutes of class time devoted to science on the days that science was taught and the average number of minutes per day of class is also listed by teacher in Table 1. Even when science was included in the instruction provided on a particular day, the amount of time devoted to a topic was generally brief, averaging from a low of 6.5 minutes for Teacher 3 in District C to about 15 minutes for three of the other teachers. Because science was taught on no more than one third of the days observed, the average amount of time spent on science on a typical day was minuscule during the first year of the study.

As can be seen in Table 1, only one teacher, Teacher 2 from District C, averaged more than 2 minutes per day across the 9 days of observation. The average of slightly over 5 minutes for that teacher hardly represents a major portion of the in-class instructional time. Excluding time spent in noninstructional activities such as recess, free play, and snack time, the average number of minutes per day devoted to total instruction by these same teachers ranged from a low of 65 minutes to a high of 126 minutes per day (Meyer et al., 1985). Looked at another way, just 1% of the total time devoted to instruction in these 14 classrooms was spent on science-related activities. Incidentally, the average number of minutes per day spent in noninstructional activities, such as recess, free play, and transition between activities, ranged from a low of 53 to a high of 225 minutes per day for these same teachers. This represents up to 75% of the school day.

Cohort 2, kindergarten. There was, however, a marked increase in the amount of time spent on science by all but one of the eight teachers who were observed in the second year of the study. The right hand side of Table 1 lists the number of days in which some time was spent on science, the average number of minutes devoted to science on a day in which it was taught, and the average number of minutes of science instruction on a typical day. It appears that a conscious effort may have been made at all three districts to spend more time introducing science concepts to the Cohort 2 kindergarten children. As a consequence, some science activity was observed on almost a third of the 117 days of observation across the 13 classrooms of Cohort 2 children. Roughly 5% of the total instructional time was devoted to science vocabulary and concepts across these classrooms in Year 2 of the study. Still, the likelihood of a child being exposed to some science concepts on a given day varied a good deal from school to school, and from teacher to teacher within each of the three districts. Furthermore, an average of about 5 minutes a day is unlikely to be sufficient time to allow a teacher to complete any kind of effective science instruction, although science instruction ranged from 0 minutes observed, up to 20 minutes once in one class.

Cohort 1, first grade. Table 2 lists the number of days during which some time was spent on science activities, the average number of minutes devoted to science on days when it was taught, and the average number of minutes spent on science on a typical day in first grade.

[Insert Table 2 about here.]

As the table shows, some science instruction took place in every classroom on at least 1 of the 9 days of observation. Across all 18 teachers, one could expect to observe some science instruction about 4 out of 9 days. The variation among teachers is substantial, however, ranging from 1 day in 9 to 7 in 9. As would be expected, the length of the science lessons is generally greater in first grade than in kindergarten, but there is a good deal of variability from teacher to teacher. Teacher 2 in District A, for example, taught science rarely (2 days in 9), and spent very little time (an average of only 6 minutes per day) on a science lesson. On the other hand, Teacher 3 in District C spent some time teaching science on 4 of the 9 observation days.

The average length of time devoted to science was a little over 30 minutes. Still, when the fact that science is not included as an instructional activity every day is taken into account, the maximum average number of minutes across all days is no higher than 15 minutes in any of the classrooms. In a third of the classrooms, the daily average for science is less than 5 minutes. One could hardly expect great growth in science concepts or in a child's skills of observation or approaches to thinking about the world around them as the result of 5 minutes effort per day.

Content Covered

When science is taught, the topics are varied. Teaching about plants, animals, the seasons, and the three forms of matter is most common. To get a sense of the nature of the instruction on these topics, we examined the interaction analyses. Given the emphasis of science educators on the importance of activity-based science programs, and results such as those reported by Bredderman (1983) suggesting that such programs have positive effects on both achievement and affective outcomes, we were particularly interested in observing the degree to which children were being provided with opportunities to manipulate, observe, and formulate hypotheses. Specific categories were created to record the frequency of these types of classroom activities. We were also interested in the degree to which the lessons were driven by the textbooks, and the extent to which they drew on the background knowledge and experiences of the children and required them to express their opinions about a topic.

Interaction Analyses

Children in the kindergarten and first-grade classrooms in our study had almost no opportunity to experiment, observe manipulations by the teacher, or to formulate hypotheses. Instead, they were called upon to reflect on their out-of-class experiences, observations, and background knowledge and to express their opinions about those experiences. The distribution of the percentage of interactions devoted to exploring background knowledge and giving opinions about their observations of plants, how forms of matter change and the like is shown in the stem-and-leaf plot on the left-hand side of Figure 1. Figure 1 shows the distribution of the percentage of background knowledge and opinion interactions teachers initiated with students during lessons in Column 1 of the stem-and-leaf plot.

[Insert Figure 1 about here.]

The number to the left of a colon represents the 10s digit whereas the numbers to the right of a colon represent the units digits for a teacher. Therefore, 6:6 in Column 1 shows that 66% of one first-grade teacher's interactions during a science lesson were a combination of background knowledge and opinion questions. In contrast, another teacher had no background or opinion interactions with students during science instruction. The last row in Column 1 is the median percentage for background knowledge and opinion interactions. About 40% of these teachers' interactions were typically of these two types.

Column 2 shows the distribution of textbook-driven interactions. This category included all teacher-initiated interactions that children were to answer from information presented in their textbooks. This category would include asking children the meaning of vocabulary words in the text, reading and discussing sections of the text, or having the children read silently or answer questions in sections of the textbook. Eight teachers had no textbook-driven interactions as they taught science, and 5 of the 7 teachers who did have interactions of this type had just slightly over 20% of this type of interaction. Therefore, it appears that at the first-grade level science textbooks are used directly very little. Asking children questions that they are expected to answer from their background knowledge, or asking them to give an opinion is much more common than interactions initiated by the textbooks. Only 7.5% of teachers' interactions typically fell into this category.

Column 3 shows the percentages of first-grade teachers' interactions that represent procedural instructions or questions to students. Directions to look at a picture, to read a segment of text, to get out a book or a worksheet, or similar instructions were included in this category. Just over 25% of these teachers' interactions were procedural. We generally think of this category as direction-following interactions. The range of teachers' interactions for procedurals is even more striking than the other categories. One teacher has 72% procedural interactions whereas four teachers cluster between 11% and 25%.

Column 4 presents the teachers' uses of general review questions. The first-grade teachers range in this category from 61% down to .010%. Questions were coded into this category if they were clearly focused upon information that had been covered previously. Just 11% of the teachers' interactions were for review.

Column 5 shows the percentages of interactions that directed children to read orally. Just 4% of the interactions were coded into this category with a range from 34% for one teacher down to about .0001% for 7 teachers. Fewer interactions went to oral reading than to any of the other five categories thus illustrating that these teachers did not turn their science lessons into reading lessons. It also appears that science textbooks provide only a limited amount of the stimulus for science instruction for most of these first-grade teachers. Children and teachers in these classrooms spend most of their time discussing what they have observed about nature outside the classroom.

The material summarized in Tables 1 and 2 and in Figure 1 provides only a very general glimpse of what is happening in the classrooms participating in this study. It provides a backdrop against which to begin to delve more deeply into not only the specific nature of the science instruction these children have encountered, but how that instruction relates to their development of science knowledge and concepts. Our research is just beginning to look at the relationships of the coverage of topics and the nature of the instruction with achievement in science. We believe, however, that the differences we have observed in the amount of time teachers spend on science, the topics dealt with, and the approach to science instruction used will help explain the subsequent achievement of these children.

Student Achievement

Results of some preliminary analyses of differences in student achievement as a function of school and teacher are summarized in Table 3. At the end of kindergarten and first grade, the only science test that we administered was the Tests of Basic Experience-2 (TOBE-2) (CTB/McGraw-Hill, 1978). At the end of second grade, however, we were able to administer a standardized science test, the Sequential Test of Educational Progress (STEP) (Educational Testing Service, 1979) and three tests especially constructed for this study based upon an analysis of the curriculum materials used in the three schools.

The first of the especially constructed tests, the Plants Test (Meyer, Hastings, & Linn, 1986a), deals with concepts about the development, changes, functioning, and uses of plants. The second, the Three Forms of Matter Test (Meyer, Hastings, & Linn, 1986b), assesses concepts about the three forms of matter, and the third, the Motion Test (Meyer, Hastings, & Linn, 1986c), deals with principles of motion. The first two topics were selected because they included concepts most emphasized in the textbooks and most frequently observed as classroom instruction topics through second grade. The Motion Test, on the other hand, covers a topic that is yet to be introduced to these students. Differences in performance at the end of kindergarten were controlled for by the children's scores on the TOBE-2.

Differences Explained by School or Teacher

The results of multiple regression analyses appear in Table 3. These analyses were run to see if there were significant differences in science achievement as measured by the four tests. Differences in student achievement in science at the end of kindergarten were controlled for by using the children's kindergarten TOBE-2 scores. District affiliation and teacher were used as predictors of performance on all four tests. As can be seen, there are no significant differences on the standardized test, the STEP, as a function of either district affiliation or teacher. There are, however, significant between-teacher differences on the Plants Test, the Three Forms of Matter Test, and the Motion Test when end-of-kindergarten performance is controlled for by the TOBE-2 scores. There are also significant between-district differences on the Plants Test and the Three Forms of Matter Test, the two customized tests that cover topics that had been taught in school, after controlling for end-of-kindergarten performance on the TOBE-2.

[Insert Table 3 about here.]

Discussion

We found scant instructional time devoted to science in either kindergarten or first grade. Furthermore, when we examined the tasks students were exposed to during their short science periods, we found that teachers most often asked students questions that they answered either from information that they already knew (their background knowledge), or that the questions only sought the children's opinions. In short, new information was not presented during these class periods.

These results strongly suggest that at the very lowest elementary grade levels, American schools have very serious problems when it comes to science teaching. Current practices are such that the children simply do not have opportunities to learn science. It is clear that elementary school teachers and administrators should begin to examine their daily schedules to determine possible changes for increasing blocks of instructional time, particularly in light of the large amounts of noninstructional time spent in most classrooms. Research in other academic areas at these grade levels suggests that at least 30 minutes per day should be spent teaching science if we want to make differences in student performance. School officials might then begin to consider what new information they want to teach at these grade levels. After adequate amounts of time are allocated and decisions are made about content to cover, it will be appropriate to plan how best to engage students while presenting those lessons.

Textbooks do not appear to be the culprits in these classrooms. These teachers simply do not teach science. It is doubtful that teachers who fail to teach science in a familiar way, from textbooks, would be likely to teach it in a foreign way, using hands-on activities. Therefore, it may be that the hurdles to science instruction in the elementary grades are much greater than those represented by current methodological debates. The problems appear to be far more serious. Therefore, the solutions will probably be much more complicated than simply shifting methodologies. It appears from the variance in frequency of science teaching that we observed that these lower-grade teachers have a great deal of autonomy to make decisions about how to spend their time, and science simply is not a priority. We believe that this is a very important finding because it changes the entire complexion of the current debate about science instruction in the elementary grades.

It is also very disappointing to discover that the little time these teachers spent in science focused upon information the students already knew. The students were not expected to make observations or formulate hypotheses. They did not see their teachers complete demonstrations, and they did not have these experiences themselves. Instead, they primarily answered questions about things they already knew. This suggests that these teachers may have misunderstood the importance of activating children's background knowledge. Research in this area has always emphasized that activating background knowledge is a critical first step in the instructional sequence, but once that has been done, it is important to introduce new information.

We suggest that research of the type we have undertaken can break the cycle of recognizing America's poor standing in science then rushing headlong into interventions that attempt to wipe out science textbook implementations to replace them with hands-on science programs. We suggest that attention should shift to recognizing how little science is being taught at all and then working within these contexts to motivate teachers to give science instruction a higher priority in their classrooms. Such reforms may need to reach from college campuses to school districts and textbook publishers before we begin to see much change in science teaching in the majority of America's elementary schools.

The results from testing these students using standardized tests and tests designed for this study after analyzing the curricula suggest that there may also be some difficulties with the ways science learning is being assessed in American schools. The contrast in the results from the four tests we administered shows that a general standardized test of elementary school science is not sensitive to differences between classes. However, the tests which we constructed to focus on the topics that are most often taught in these particular grades at the three districts in the study are sensitive to these differences. Therefore, there appears to be a need to develop more sensitive instruments for assessing science if we want to be able to measure student performance more accurately.

Future Research

The goal of the analyses that we are currently working on is to use the data from the classroom observations to try to explain the differences in achievement at each grade level. We hope to be able to demonstrate, not only that the variation in time spent in science instruction is an important determiner of subsequent achievement, but that there are important differences as a function of the way in which that time is spent.

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Authors' Note

The authors wish to acknowledge the contributions of the field staff: Betty Boyd, Lorraine Crummey, Marlene Engberg, Eunice Greer, Kathy Harper, Susan Herricks, Eleanor Hopke, Jennifer Hughes, Joan Levy, and Penny Lopez, who completed and coded the classroom observations and tested children, and who have not only worked together to collect these innumerable data sets but have provided substantial comments at levels too numerous to recall.

Table 1
Time Devoted to Science in Kindergarten for Two Cohorts of Students

		Cohort 1			Cohort 2		
District	Teacher[a]	Days Science Taught	Avg. Time (Min.)	Typical Time (Min.)	Days Science Taught	Avg. Time (Min.)	Typical Time (Min.)
A	1-AM	0	.0	.0	4	17.5	7.8
	1-PM	0	.0	.0	1	18.0	2.0
	2-AM	1	17.0	1.9	0	.0	.0
	2-PM	1	14.0	1.6	1	15.0	1.8
District average		.5	7.8	.9	1.5	12.6	2.9
B	1-AM	1	9.0	1.0	4	11.0	4.9
	1-PM	1	8.0	.9	3	11.0	3.8
	2-AM	1	16.0	1.8	4	11.2	5.0
	2-PM	0	.0	.0	3	13.7	4.6
	3-AM	0	.0	.0	1	9.0	1.0
	3-PM	0	.0	.0	0	.0	.0
	4-AM	0	.0	.0	Did not	teach	Yr. 2
District average		.4	4.7	.5	2.5	9.3	3.2
C	1-WD	0	.0	.0	3	20.7	6.9
	2-WD	3	16.0	5.3	7	13.7	10.7
	3-WD	2	6.5	1.4	4	28.0	12.4
District average		1.7	7.5	2.2	4.7	20.8	10.0
Overall average		.7	6.2	.7	2.7	13.0	4.7

[a]*Note.* A given teacher is denoted by a unique number within school, AM refers to the teacher's morning class, PM to an afternoon class, and WD to a whole-day kindergarten class. Except for Teacher 4 in School B, all teachers were observed for two years with both cohorts.

Table 2

Time Devoted to Science in First Grade - Cohort 1

District	Teacher	Days Science Taught	Avg. Time When Taught (Min.)	Avg. Time on Typical Day (Min.)
A	1	3	17.0	5.7
	2	2	6.0	1.3
	3	5	12.0	7.8
	4	7	17.7	13.8
District average		4.2	13.2	7.2
B	1	5	16.6	9.2
	2	2	21.5	4.8
	3	2	19.0	4.2
	4	1	27.0	3.0
	5	6	11.0	7.3
	6	2	16.0	3.6
	7	4	22.5	10.0
District average		3.1	19.1	6.0
C	1	6	23.3	15.6
	2	4	11.5	5.1
	3	4	32.5	14.4
	4	4	20.2	9.0
	5	5	18.0	11.2
	6	3	32.3	10.8
	7	3	14.0	4.8
District average		4.1	21.7	10.1
Overall average		3.8	18.8	7.9

Table 3

Prediction of Achievement on Science Tests at the End of Second Grade from End of Kindergarten Pretest, Pretest Plus School, and Pretest Plus Teacher

STEP Science Subtest			
Predictors	Squared Multiple Correlation	Change in R^2	Significance Level of Change
TOBE-2	.196	.196	.01
TOBE-2 + District	.203	.007	NS
TOBE-2 + Teacher	.268	.072	NS
Plants			
TOBE-2	.160	.160	.01
TOBE-2 + District	.197	.027	.01
TOBE-2 + Teacher	.274	.114	.01
Three Forms of Matter			
TOBE-2	.214	.214	.01
TOBE-2 + District	.241	.027	.01
TOBE-2 + Teacher	.328	.114	.01
Motion			
TOBE-2	.099	.099	.01
TOBE-2 + District	.110	.011	NS
TOBE-2 + Teacher	.202	.103	.05

Figure 1

Stem-and-Leaf Distributions of the Percentage of Teacher Science Interactions by Category

Background Knowledge & Opinion	Textbook Driven Interactions	Procedural	General Review	Student Oral Reading
Stem: Leaf	Stem: Leaf	Stem: Leaf	Stem: Leaf	Stem: Leaf
7:	7:	7: 2	7:	7:
6: 6	6:	6:	6:	6:
6: 013	6:	6: 0	6: 1	6:
5: 5	5: 8	5:	5:	5:
5:	5:	5:	5:	5:
4: 7	4:	4:	4:	4:
4: 234	4:	4: 23	4:	4:
3: 9	3: 8	3:	3:	3:
3: 1	3:	3: 4	3:	3: 4
2: 57	2:	2: 56678	2: 7	2:
2: 012	2: 13	2: 00344	2:	2:
1:	1: 56	1: 68	1: 6	1: 6
1: 2	1: 03	1: 1	1: 1122334	1: 01
0:	0: 666778	0:	0:	0: 5667
0: 0	0: 1344	0:	0: 00133445	0: 0001113344
Median Percent of Interactions				
40.3	7.5	25.5	11.0	4.0