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AUTHOR Lee, Okhee; Gallagher, James J.
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ABSTRACT

Based on the assumption that teaching behavior is influenced or determined by teachers' theories and beliefs of teaching, this study sought to examine how middle school science teachers perceive their instructional roles and how they go about improving their instructional effectiveness. Eleven teachers from two middle schools of the Midwest participated in the study. Classroom observations and formal and informal interviews with teachers, administrators, and students comprised part of the data sources. Reviews of texts, other instructional resources, tests, policy documents, and a series of three workshops provided additional data. About 350 science classes were observed by two researchers for 18 months. The findings are summarized in two sections in this report. The first section explains how it was determined if teachers were effective in presenting information and organizing learning activities. Observations on diagnostic and remediation efforts are reported in the second section. Generally, it was found that many teachers were ineffective in presenting and organizing information and in diagnosing student difficulties in learning science. Possible causes and consequences of this situation are outlined and implications are reviewed. A reference list is included. (ML)

Middle School Science Teachers' Perceptions of Their Instructional Roles

Okhee Lee
James J. Gallagher

College of Education
Institute for Research on Teaching
Michigan State University
East Lansing, Michigan, 48824

Introduction

Clark and Peterson (1985) state, "The thinking, planning, and decision making of teachers constitute a large part of the psychological context of teaching. It is within this context that curriculum is interpreted and acted upon. Teacher behavior is substantially influenced and determined by teachers' thought processes." Under these assumptions, research on teacher thinking seeks: First, to describe the mental lives of teachers; and second, to understand and explain how and why their observable activities take on the forms and functions they do (see Shavelson & Stern, 1981).

In their model of teacher thought and action, Clark and Peterson (1985) relate two domains that are involved in the process of teaching: (a) teachers' thought processes and (b) teachers' actions and their observable effects. They emphasize that these two domains have a reciprocal, or cyclical, relationship: one affects the other, which in turn affects the former. They also state that, for a complete understanding of the teaching process, we should understand the constraints and opportunities that impinge upon it, either with or without the teachers' awareness (see Good and Brophy, 1985, for a review of school environment).

They then divide the domain of teachers' thought processes into three categories: (a) teacher planning, (b) teachers' interactive thoughts and decisions, and (c) teachers' theories and beliefs. First, teacher planning includes the thought processes teachers engage in prior to and after the classroom interaction. They review many types of planning which are nested and interact with one another, such as, daily, weekly, yearly, lesson, unit, etc. During the planning process, teachers use a variety of resources, the primary ones being curriculum materials and their memory of lessons taught in previous years. Through planning, they feel more confident in their ability to teach. Second, research on teachers' interactive thoughts and decisions investigates what teachers think while interacting with students in the classroom. Studies report similar findings about the content of teachers' interactive thoughts. The greatest percentage was concerned with (a) the learner; then (b) the instructional procedures and instructional strategies; (c) the content or the subject matter, and finally (d) the instructional objectives. Third, the category of teachers' theories and beliefs represents the rich store of knowledge teachers have that affects their planning and their interactive thoughts and decisions. Most studies deal with teachers' perceptions of the causes of students' performance, that is, whether teachers attribute students' success or failure to themselves or to other factors, especially to the students.

They summarize that teachers plan in a variety of ways, make frequent decisions during interactive teaching, and have theories and beliefs about teaching and learning. Thus, as a reflective professional, a teacher has to be knowledgable of the following: (a) discipline and subject matter, (b) students' thought processes (Wittrock, 1985), and (c) theories and strategies of teaching, in order to effectively deliver the content to the students. In

addition, he should know how to cope with the constraints and opportunities that affect the process of teaching.

Given the assumptions that teachers are professionals and that their behavior in the classroom is influenced or determined by their theories and beliefs of teaching, the questions of this study were to investigate: (a) how middle school science teachers perceive their instructional roles, as viewed through their actual practice of teaching; and (b) how they go about improving their instructional effectiveness.

These questions imply the need for descriptions of behavior and understanding of what lies behind the actual behavior. Due to the nature of the questions asked, the approach being used is ethnographic.

Purpose and Methodology

This study is a part of research project in which more than 1,000 secondary school science classes were observed in five secondary schools located in two school districts (Gallagher, 1985). The focus of this study was specifically on middle school science. There seem to be several major features that distinguish middle school science classes from high school science classes. First, middle school science curricula tend to be more general in content than that found in the high school science curricula. Furthermore, all the students are supposed to take certain courses at the same grade level, unlike required or elective courses in high school. Second, except in some special programs such as "enrichment programs" for high achieving students in science, students in middle school are not tracked according to their ability. Finally, in middle school classrooms, management is a prominent part of the teacher's role; while in high school, the classrooms assume an increasingly academic focus (Brophy & Putnam, 1978).

The schools involved in this study were two middle schools from two school districts in the Midwest. Students in both schools ranged from grades 6 through 8. One of the schools was located in a middle class neighborhood in the capital of a state. This school drew a varied population of students representing a wide range of socio-economic and racial backgrounds. Approximately 40% of the student population were black, 15% were Hispanic and oriental, and the rest were white. The other school was located in a suburban of the capital city. Nearly all students in this school were white. They came from families that represented a mixture of socio-economic levels, including farmers, small business operators, government workers, university faculty, factory workers, and unemployed persons. The general climate of the community may best be characterized as moderately conservative.

Eleven teachers participated in this study: nine teachers of four female and five male from an urban middle school; and one female and one male teachers from a suburban school. One male teacher in the urban school had taught physical education and the female teacher in the suburban school, home economics. All the other teachers had majored or, at least, minored in science. All were experienced teachers who felt that they had mastered the

tasks of instructional management.

In this study, about 350 middle school science classes were observed by two researchers for the duration of 18 months since fall, 1984. In addition to classroom observations, formal and informal interviews with teachers, administrators, and students comprised part of the data sources. Review of texts, other instructional resources, tests, and policy documents provided additional data. In addition, a series of three workshops with a group of 6th grade teachers in the urban school comprised key data sources.

During the process of participant observation, we developed assertions to answer our research questions with the assistance of other project staff members. We gathered evidence which would confirm our assertions. Moreover, with a view to triangulating the evidence in confirming or disconfirming the assertions, special attention was paid to discrepant evidence. The discrepant evidence permitted us to more accurately understand the situation (Erickson, 1985).

The purpose of these varied activities of data collection and analysis were to deepen our understanding of the work of middle school science teachers and to gain insights into the values, beliefs, and forces which shape it. We were especially interested in gaining a better understanding of the teachers' perceptions of what constitutes teaching and how they might go about improving their effectiveness.

Teachers' Role Perceptions

What were the role definitions or beliefs of middle school science teachers about (a) the central functions of their instructional roles and (b) how these functions should be accomplished. Most teachers considered themselves to be subject matter specialists, with little emphasis on other aspects such as socializers. The following example shows how teachers perceived themselves as such.

During the second day of the school year, a seventh grade teacher told all his classes to answer the following three questions: (1) What does science mean to you?; (2) If you could accomplish (do) anything in science you wanted, what would you like to do? (60 words); and (3) What do you believe is the greatest problem facing the world today that could be solved by scientific studies and advancement? (one or two words). How could you accomplish or solve this problem? (30 words or more). Another example was the teacher who said that she did not care whether students liked her or not as far as they learned the science content from her class.

Perceiving themselves as subject matter specialists, they believed that their primary teaching role was to present information and organize learning activities through assignments, lectures, films, laboratory activities, etc. They, however, did not view diagnosing and nurturing student learning as their roles. Instead, they appeared to transfer the responsibility for subject matter mastery to their students. All seemed to convey that their image of teaching was presenting information, and it was the responsibility of students to learn it. This led the teachers to

believe that "good students with ability and motivation" will expend necessary effort to master the subject matter while the rest won't.

In the following two sections, we describe how teachers' perceptions of their instructional roles were revealed in their actual practice of teaching in the classroom. We first consider how effective or ineffective teachers were in presenting information and organizing learning activities. Then, we describe how they succeeded or failed to act to diagnose and provide remediation for students who were experiencing difficulties in learning the science content. One thing to note about our interpretations of the data is that, even though they may sometimes sound evaluative, our primary concern is to describe what happened in the situation and what underlay the teachers' actual behavior.

Presentation and Organization

If middle school science teachers saw their instructional roles as presenters of information and organizers of learning activities for their students, how effective were they in fulfilling these roles? Our answer to this question is they would receive "low marks." Even though they perceived their roles as presenters and organizers of the content, their actual practice of teaching was marginal. We summarize our observations under the following topics. For each assertion, we present evidence which either confirm or disconfirm it.

Planning. In contrast to Clark and Peterson's (1985) work on teacher planning, we seldom observed teachers spending time on preparation and planning for their classes. During a planning hour, teachers spent time doing something else rather than in their classroom. Many teachers finished their work and left school soon after the last class period was over. One teacher, when asked how she prepared for her class, responded that since she had taught the same subject for ten years, she didn't have to prepare but used the instructional materials that had been accumulated.

However, there were a few teachers who sometimes spent a fair amount of time preparing for their classes. One of the researchers saw a teacher staying in his classroom after school. Asked what he was doing, he said he was planning what he would be doing in his class the next day. He said he usually did not leave school until he finished planning for the following day. On another occasion, this same teacher scolded students during lab class. He said he was very disappointed with the students because, despite the extra hours he spent the previous day in preparing for this lab, they were not working up to his expectations.

Presentation. Since many teachers tended not to plan for their classes, most presentations of information in class appeared to be largely extemporaneous. The details of the content presentation was poorly planned and teachers were easily distracted from their intended direction by questions from students or by their personal interests. Often an initial diversion was followed by continuing questions or issues, which led the class discussion further away from the main point. One

teacher started a chapter on the human body. There was a picture of people playing soccer in the textbook. The teacher talked about soccer for a minute and then came back to the content on the structural system of the human body. At that moment, another male teacher passed through the classroom to the coffee room adjacent to this room. The teacher called the other teacher and they talked about soccer and basketball, while students were listening to them. This conversation lasted about 10 minutes.

The effect of this pattern of activity in lecture-discussions was a loss of the continuity of thought by students and even by the teacher. These sessions could be interesting and informative about specific factual knowledge, but they usually did little to help students comprehend the scientific principles and relationships that underlay the intended lesson or the side issues raised by students' questions. For example, one teacher often used personal experience or everyday phenomena to explain the concepts. These personal anecdotes were interesting and made students feel more familiar with science content. However, these examples sometimes were not related to the content of instruction. This teacher one day asked several questions about moss, whether it had roots or stems, where it lived, etc. The teacher then began to talk about his experience of fishing when he went camping as a college student. When two girls talked to each other in class, the teacher reminded them to be quiet saying that if they happened to go camping and have a chance to fish, they might need the information he was relating. When he finished his story, one boy raised his hand and asked the teacher why he brought the story up in class. The teacher did not respond to him.

In contrast, there were a few teachers who presented information which seemed well planned. They combined both the concept and example in such a way to enable students understand the concept more easily as well as be interested in learning it. One teacher, explaining the concept of convection, took an example from his experience as an adolescent when his family lived near the ocean. When he began smoking secretly upstairs, his mother who was cooking in the kitchen downstairs rushed into his room. He posed the question as to how his mother knew what was going on in his room. Then, he related this example to the convection of air.

Organization. As organizers of instruction, most teachers would also receive "low marks." Literature and general belief say a good lesson consists of three phases: introduction, development, and conclusion. In most classes, however, we rarely observed teachers introducing or summarizing the content of their lesson.

Rarely did we observe teachers using advance organizers to introduce lessons or prepare students for the lesson that was to come. Teachers usually started the class by directing students to the text without any specific, brief introduction to the content of the day's lesson. All the introduction teachers usually gave at the start of a class was that students would learn about something and that they should open their textbooks to a specific page. At times teachers went directly into the content they had finished the previous day without any review.

We seldom observed teachers summarizing the content of the instruction at the end of the class either. They typically were

too rushed to finish up what they had intended to do, and had no time remaining to summarize what was learned in class. Especially where students were permitted to leave the classroom when the bell rang rather than being dismissed by the teacher, they rushed out of the room while the teacher was still talking. After labs or films, teachers usually did not have time for a review or discussion in class. This usually resulted from a failure to plan for the length of the film in the day's lesson. Teachers sometimes told the class that they had not seen the film yet. Many times the bell rang before the film was finished.

Thus, usually with no introductions or summaries for their lessons, most science lessons had neither beginning nor ending--they were all middle. The consequence of this was that many students were not able to understand the instructional content, and they perceived the body of scientific knowledge as vast, unconnected, and difficult to learn.

The organization of learning activities also tended to be poorly orchestrated. Individual components of instruction, such as, films, seatwork, homework, lecture-discussions, labwork, etc. were not integrated so as to help students learn the intended content. Thus, the whole of these activities may be less than the sum of its parts. For example, films were used more frequently than desired. Despite their frequent use, however, films were not related with other activities but tended to be a diversion from the main line of instruction. One teacher showed several films at the same time after finishing a chapter. Since the whole class period was spent on films, some students fell asleep during the latter half of the period. The teacher did not react to these students. Rarely were there pre- or post-discussions of the films.

However, there were cases when a few teachers organized several activities in an integrated manner. One sixth grade teacher showed a film about littering that lasted for 20 minutes. The content of the film was very simple: A dog (similar to Lassie) finally succeeded in convincing a man to clean a riverside full of garbage. During the remaining 25 minutes of the period, the teacher engaged the class in a discussion on littering. She led the discussion from the issue of decomposition and pollution from garbage dumps, through the state law requiring 10 cent deposit for beverage containers, to the importance of cleaning the hallway in the school building and one's community. Students actively participated in the discussion.

Another example was one sixth grade teacher who carried out two labs in the same period. The first lab was to investigate how the movement of dyed water changed when salt was added. The second lab asked what happened when warm dyed water came in contact with cold clear water. Students were supposed to report the results and their conclusions. One group did not get the same result as the other class members. For the last seven minutes, the class discussed what results were obtained and what conclusions could be drawn from them. The class also discussed what might be the possible reasons one group got different results from the others. If it had not been for the discussion after the labs, some students might not have acquired the concepts.

Teaching strategies. The range of teaching strategies used by any one teacher tended to be rather narrow. Most teachers employed a small repertoire of routinized activities. The major methods were lecture-discussion and seatwork. One eighth grade teacher filled most of the class time having students do seatwork. Her major pattern of teaching consisted of: giving an assignment to students, having them finish it, going over it with the class, then giving another assignment, and this pattern kept being repeated class after class. While students were working on paper work, she checked and graded students' papers or tests at her desk. Several students complained that the class got boring because the teacher gave too much paper work all the time.

However, there were a few teachers who used varied teaching activities which filled their classes with excitement. One seventh grade teacher used lectures, class discussions, films, projects, labs, and seatwork. Many students in his classes said science was their favorite subject and that they really liked his class. We talked with several eighth graders who had both of the above teachers in consecutive years. They talked about how boring the first teacher's classes were and that they missed the second teacher's.

Some teachers had routine procedures that sparked excitement. One teacher began each class with a "mindstretcher," a challenging question which derived from and constituted an application of the previous day's lesson. This activity required less than 10 minutes from the bell signalling the beginning of class to initiation of the day's lesson. Another teacher used probing questions as a way of determining his students' understanding of the content and its applications. After showing a film on volcanic regions, this teacher asked the class whether there was any evidence or remains that the state of Michigan had once had volcanos 200 million years ago. Since this question was open-ended, students expressed their ideas freely and discussed the validity of their answers in class.

Instructional objectives. The relative neglect of instructional objectives by teachers appeared to be problematic, in the sense that students were often dimly aware of the purpose of academic activities and had difficulty explaining what they were learning and why they were learning it. One teacher spent up to 10 minutes introducing the lesson at the start of class. This introduction, however, was all about procedures without any introduction or objectivies of the content. The typical pattern was: do this first, then do that, then do another, and when you finish all these, check with me. Moreover, when one researcher raised the issue of instructional objectives during an interview, this teacher seemed confident of what she was doing in class.

Lack of instructional objectives was a problem, especially during lab work. The only introduction students sometimes received about labs was to read the introduction section before starting and to follow the procedure as stated in the textbook. However, when the teacher asked students at the end of the lab about the conclusions that could be drawn from the activity just completed, the students had little comprehension of its purpose.

As an example, one class did lab on predicting the weight of different volumes of water. The teacher told the class to read

the introduction section and follow the procedure in the textbook. The procedure of the lab was: weigh an empty jar; pour two inches of water in the jar and weigh it; predict how much the jar would weigh if water was poured another two inches higher; measure the actual weight of the jar with four inches of water in it. Students were to report what was the difference between the predicted weight and actual weight, and why there was this difference. The jars used were round-shaped at the bottom edge and also dented at the bottom. At the end of the lab class, the teacher asked the students what were their results and conclusions. Some students asked back, "Where are the questions? We didn't see any questions." Since the lab exercises were printed in the textbook in a statement format, not in a question format, students didn't recognize the purpose of the lab. We observed his next period on the same day. At the start of the class, to avoid another "non-sense" episode, the teacher told the students what happened in the previous class. He emphasized that certain numbers of statements were actually questions and that responding to these statements was the purpose of the lab.

Diagnosis and Remediation

During our observations of middle school science classrooms, we saw very little evidence of teachers acting to diagnose and remediate difficulties which students were experiencing in comprehending the subject matter of science. We summarize our observations under the following topics.

Questioning students about their understanding. During lecture-discussion, teachers tended to continue presentation of content with almost no time devoted to questioning students about their understanding. When validation of students' comprehension did occur, teachers typically would respond to wrong answers by calling on another student who could give a correct answer. In many cases of incomplete or partially correct answers, teachers would elaborate and expand to provide a more complete answer. Moreover, some teachers used questions to check whether students were on task, or sometimes to embarrass them rather than to get their attention back to class. On one occasion, a teacher asked students the distinction between two words, control and experiment. Only one girl (called Lisa) raised her hand in class. The teacher designated another girl to answer. The girl murmured. The teacher said, "Control means to turn your face to the front, right?" The girl tried, "Control means...," and became silent. During this interaction, Lisa put her hand down. The teacher then asked another girl, and she said, "I don't know." The teacher then turned to Lisa and said, "OK. Lisa." Lisa gave a correct answer, and the teacher expanded upon her answer.

However, a few teachers tried to give opportunities to as many students and help them with their answer. When this happened, the teacher spent more time on waiting for students' responses and asking several intermediate questions. However, the atmosphere of the classroom was more permissive and cooperative, and many students were willing to express their ideas during discussions. When a boy almost gave up answering a sequence of questions by a teacher, the teacher encouraged him that she would give him a chance and help him. With the help of several

intermediate questions, the boy finally answered correctly, and the class gave him a hand.

Seatwork. During seatwork, which would be an ideal time for teachers to monitor students' work and to help individuals who were having difficulty in understanding the content, most teachers did clerical tasks at their desks. They rarely walked among students to check their work as an effort toward diagnosis and individual remediation. Especially around the end of a marking period or a semester, most teachers gave assignments to students while they were working on students' papers or grades. As an example, during five observations throughout a period of two weeks before a marking period, while students were working on seatwork or taking tests, one teacher worked on students' papers and grades without leaving her desk. Since both the teacher and students were occupied with own work, many students during this period did not have any chance of talking to the teacher individually, nor were there any whole-class interactions through lecture or class discussion.

Occasionally, students would raise their hands and the teacher would go to their seat or call them to the desk. However, low achieving students needing more help tended not to ask for it; whereas, the better students tended to be more assertive in requesting clarification and assistance. This seems contradictory to the purpose of seatwork to help individual students with their progress and especially to diagose and remediate those having difficulty. As a consequence that teachers tended not to volunteer go give assistance and that students who got the teacher's help tended to be more able students, those students who needed more attention and help actually received less.

Homework. Teachers' review of students' homework also gave clues regarding their view of teaching. Typically, teachers checked homework to determine its completeness and then recorded its "presence" in their grade book. Due to the large volume of homework papers (often 3-4 assignments per week each 1-2 pages in length from 150 students) and since teachers did not expend their time for class work after school, the bulky homework papers had to be managed sometime during the class hours. The consequence of this situation was that few teachers read or made comments on students' homework and that a check mark at the top of the paper was all the feedback students received from the teacher.

It appeared that teachers believed that homework was an important part of the work that students must do to learn science and therefore, a large volume of homework was assigned. However, the volume of homework was counter-effective in its use by teachers as a teaching tool in the following ways: (1) Teachers could not read all of the homework papers and provide students with feedback on their work; (2) Teachers, therefore, could not use homework as a diagnostic tool to become more perceptive about their own teaching or student learning; and (3) To give students timely feedback on homework, teachers often had students check their own (or other students') homework, and its consequence was superficial analysis and/or design of homework tasks which were easy to check such as vocabulary definitions or factual information rather than the evaluation of higher cognitive level learning.

Feedback. Often a check mark at the top of seatwork or homework paper was all the feedback students received from the teacher. A score was all that students got as a test result. One teacher explained to the students that, on the assignment papers they received, "+" meant excellent, no sign meant acceptable, and "-" meant poor. Later in this same class, in contrast, a student teacher made detailed comments on each student's project. This suggests that teachers seemed to know the importance of feedback to students, but for some reason, they failed to give feedback.

During class interactions between the teacher and students, teachers sometimes did not give feedback to students' responses. Students, on the other hand, were very sensitive to teachers' feedback and sometimes requested it in class. One boy was eager to answer a question and asked a teacher to give him a chance. The teacher designated him; the boy answered; but the teacher did not respond to him. The boy asked the teacher whether his answer was correct or wrong. To his request, the teacher then said that was correct. As another example, one of the researchers was sitting next to a boy in class. Receiving his assignment paper back, the boy exclaimed that he could not believe he got a B on the assignment. The teacher was standing near him threading the film projector. The boy told the teacher with excitement that he got a B on his assignment. There was no response from the teacher.

Lack of teachers' feedback to various kinds of students' performance resulted in not only students' feeling of uncertainty about their level of performance but also no diagnosis and remediation for their difficulty in learning the content.

Causes and Consequences

In the previous two sections, we have described how middle school science teachers perceived their instructional roles. The evidence supported our assertions that many teachers were ineffective in presenting and organizing information and teaching activities as well as diagnosing and remediating difficulties which students were experiencing in comprehending science content. Why do these conditions exist? What underlay the actual behavior of teachers in their classroom? The following are some of our answers for these questions at this moment, which need to be supported and elaborated by further data.

First, teachers did not discuss teaching with one another. During our observation, we rarely observed teachers talking with one another about teaching. They conversed about many things--students, school activities, sports, politics, administrators--but they did not talk about teaching, instruction or curriculum very often. Moreover, when they did, their talk was neither rich nor elaborated. Instead, it focused on resolution of specific problems.

Second, there was almost no supervision of classroom instruction. None of the teachers observed other teachers' classrooms. We also did not observe administrators visiting any classroom. Teachers and administrators had relatively little interaction regarding instruction or the curriculum. Both seemed to be attending to separate agenda and only worked together

superficially regarding what should be taught and how teaching should occur. One teacher reported that, during her 11 years of teaching practice, she had never been observed by any other teacher or administrator in her class, except when she was on probation during her first year of teaching.

Third, teachers felt that they were effective. They appeared to believe that they could learn little about teaching from one another, from administrators, or from outsiders such as university professors. Knowledge of subject matter content was different--teachers sometimes were observed to ask another teacher (or project staff members) about science content, but we were rarely asked about how to teach it nor did we observe teachers asking others about teaching strategies.

Fourth, teachers tended to be highly autonomous in determining instructional content, methods of teaching, and academic standards. "Boundaries" regarding acceptable content, teaching style, and standards were very broad. Each teacher appeared to have considerable freedom in selecting content and setting standards. Since most teachers worked quite independently with little coordination among teachers, those seriously in need of help with instructional decisions and classroom management received none.

Finally, teachers had a heavy teaching load in school. Nearly all teachers taught four or five classes per day, five days per week, each with 25-35 students, often in two or three different subject areas. Generally, one period was allowed for planning and a lunch break was given which might be 30 minutes in duration. Between classes, there was a five minute break, but teachers were expected to monitor the corridors which were jammed with students rushing to the next class. Thus, teaching days were very full.

In addition, teachers were over-extended. Most teachers were busy after school with coaching, clubs, civic activities, recreation, small business, family, etc. This left little time for planning, grading papers, background reading and enrichment, or learning about new pedagogical approaches. These filled their evenings and weekends and generally precluded time for preparation and clerical activities that were associated with teaching.

What were the consequences of this set of circumstances? Some of the answers to this question were already explained in the description of teachers' instructional roles, as viewed through classroom observation. Even though full answers may not be given yet, we tentatively summarize as follows:

a. Planning and preparation for teaching was very limited, which resulted in loosely structured instruction.

b. Teachers used a narrow repertoire of teaching activities routinely.

c. Teachers used the time during seatwork and films as a convenient device for grading papers or catching up on other clerical work.

d. Poor orchestration of learning activities resulted in failure to help students make the transition from entry level to desired state.

e. Cognitive level of instruction was decreased to the

extent that knowledge of vocabulary received major attention, while reasoning skills, scientific principles, and problem solving tended to be neglected. As an example, one boy asked a girl whether she finished defining the 40 words homework assignment. She responded they were exactly 39 definitions. We observed that half of them were reviewed during the day's lesson.

f. Textbooks were the main source of instructional content. Few instructional resources were used by teachers to supplement the adopted textbook in guiding and enriching instruction. Moreover, most of the seatwork and test materials came with the textbook.

g. Several students (about 5-7) in a class received and answered the majority of the questions during whole-class interactions. These students were highly motivated and high achievers, called "target students" (Tobin & Gallagher, 1985; Cline, 1986). Based on the responses of target students to key questions, teachers paced instruction and moved from one topic to the next. In contrast, the majority students of average and below average ability and motivation received relatively little attention and assistance from teachers.

Implications for Science Teaching: Teacher Workshops

A group of four 6th grade teachers in the urban middle school became the voluntary participants in a series of three workshops (total duration = 10 hours) designed to help them utilize the district-wide adopted texts in sixth grade science. Neigher the text nor the adoption procedures had been to their liking. As a consequence, we began the workshops with very disgruntled teachers who found the text difficult to use. The inquiry model of teaching promoted by the text did not coincide with the more direct, didactic approach which the teachers preferred. Moreover, teachers felt that this text had been forced upon them without their participation in its choice. In what follows, we highlight the major focus of discussion during the workshops.

The first workshop was a gathering of nine people: four sixth grade teachers, the school principal, the department head, the district science coordinator, and two project staff members. One of the most relevant issues raised by the teachers was the questioning of the textbook on epistemological grounds, particularly on the matter covered with "ways of knowing." They highlighted the difficulties in evaluating experiments in which, according to the textbook authors, "any response is acceptable." (This expression was common all along in the text, according to the teachers.)

The district science coordinator continuously defended the textbook on the grounds that it is different from the traditional "cook-books," since the former emphasizes on science as a process while the latter is more content-specific. The project coordinator (Dr. Gallagher) emphasized the idea that in science textbooks there must be a balance between science "as a process" and the "scientific" content imbedded in the text. After the workshop, teachers expressed their willingness to take part in future workshops of this kind.

In the second workshop, all participants in the first workshop were present with the exception of the district science coordinator. The workshop reflected the shift from procedural types of issue ("know how") in the first workshop to a different epistemological issue ("know what"). Teachers questioned the textbook on the grounds that the information given lacked a clear conceptualization of the scientific ideas which were introduced in the chapter (ecosystems). It was also stated that the textbook did not present adequate starategies that lead students to make generalization of scientific theories.

The project coordinator initiated the second workshop by asking teachers to report on their progress in the program and to indicate the pitfalls, if any, they had had with the addition of some changes in the process. From then on, teachers took control of the discussion moderated by the project coordinator. Apparently teachers wanted to go "beyond" the information given in the textbook, sharing related information and ideas with each other. The discussion also indicated that even though they occasionally got together to plan their teaching activities, they were a different stages in the program and that when changes were introduced to it, these changes were not known to other teachers. At the end of the workshop, teachers acknowledged the usefulness of such workshops in terms of academic improvement of teachers and program enrichment.

The final workshop began with a discussion of what the project staff members could do to assist teachers in return for the help they had provided us. From this discussion, it became clear that what teachers wanted was to have "their work done" as they wanted us to assist with group work (lab) and seatwork. As the workshop proceeded, teachers expressed their desire to think reflectively how content and process could be taught effectively and how knowledge gaps in the text could be overcome.

During the workshops, with time available for discussion, the participants established a climate which engendered mutual respect for one another. It was not easy at first, partly due to lack of common vocabulary to describe ideas and partly due to teachers' frustration with the text. But as confidence and vocabulary expanded, it became evident that teachers (a) enjoyed talking about teaching in a relexed setting, (b) had important understandings of subject matter and how to teach it that could be shared, and (c) recognized that their teaching could be enriched through dialogue. However, it required time, which teachers typically did not give because of their non-instructional obligations, both assigned and elected.

Subsequent observations in teachers' classrooms showed some important changes. Teachers were using the textbook more effectively as an instructional tool. There was more student-centered activity, more student-teacher dialogue, and more discussion of acitivities. Moreover, the teachers expressed their gaining of confidence with what they were doing in the classroom. As one female teacher put it, "When I am not sure of what I am doing, it does not work. Kids are having more difficulty and they seem to sense it. These workshops have helped me be assured of my purposes and now I can teach better" (paraphrased).

This series of workshops have significant implications for improving middle school science teaching. These implications are consistent with those that can be drawn from our classroom observation.

The first implication is empowering of teachers with a feeling of confidence in their teaching practice. In the first workshop, under the chair of the project coordinator, teachers were partially participating. The second workshop was less formal and the conversation was primarily led by the teachers through sharing of their ideas and experience. At the end of the second workshop, teachers said they liked it better than the first one. As the workshops proceeded, teachers expressed their desire to think reflectively about the process and content of teaching. Thus, given freedom for and confidence in expressing their thinking, teachers revealed themselves as reflective professionals.

Second, teachers need communication with administrators. During the beginning phase of the workshops, the teachers, the department chairperson, and the principal expressed their own concerns from different perspectives. However, as common vocabulary expanded and the participants began to understand each other's problems and interests, they became more aware of others' perspectives and shared common concerns. The principal and department chairperson did not hesitate to suggest their ideas and express their commitment to help the teachers.

Finally, teachers also need communication with researchers and research findings in order to keep the advancement of knowledge in the discipline and pedagogy to date. Since they had taught the same subject for years in the same classroom, they might not recognize any need for change or improvement. After the series of workshops, teachers occasionally asked project staff members for assistance with their planning or teaching process where the staff members had more expertise. Teachers appeared to become more open to communication with others for the improvement of their teaching.

As a final comment, the project started an intervention program called "peer coaching," in which three teachers and the department head from the urban school volunteered for participation. In this program, three or more teachers observed each other using some previously agreed upon observational plan with the teachers taking turns in observing one another. The observer and the observed teachers then met after each observation to discuss what was noted as well as changes that might occur and then planned the next observation. The results from this program will be very informative of how teaching actually can be enriched and improved through dialogue with other teachers in the same setting.

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