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ABSTRACT

This project examines the development of programs and strategies to help teachers include a variety of instructional behaviors that will, in turn, stimulate many kinds of student thinking. A voluntary group of teachers formed study teams to learn the Dimensions of Learning Model and implement strategies from the model in their classrooms. The first stage of the project was to assist the group in permanently changing their teaching behaviors. The second stage, reported in this document, was to assess the effect of the model's implementation on student thinking and learning. Several forms of assessment including videotaping, retention tests, questionnaires, application tests, and standardized tests were utilized. Results were compared with those of similar students in control groups who had not experienced strategies from the model or against preimplementation data from students in the experimental groups. In most cases, the experimental group achieved significantly better than the control group; in some cases no significant difference was shown; and in no case did the control group show better achievement. Twenty appendixes comprise approximately half the document. (Contains 34 references.) (LL)

DIMENSIONS OF LEARNING:

A MODEL FOR ENHANCING STUDENT THINKING AND LEARNING

by

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Submitted in partial fulfillment of the requirement of the National Ed.D. Program for Educational Leaders

Nova University

Major Applied Research Project
Final Report
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Abstract

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TITLE: Dimensions of Learning: A Model for Enhancing Student Thinking and Learning

ABSTRACT: The purpose of this project was two-fold. A voluntary group of teachers formed study teams for the purpose of learning the Dimensions of Learning model of thinking and to implement strategies from this model in their classrooms. The first stage was to assist this group in permanently changing their teacher behaviors. This was accomplished through collegial study teams with a focus on "teacher as researcher." Elements of adult learning and a change model were used to assist the group. Results are reported in Collegial Study Teams: An Implementation Model for Changing Teacher Behavior Relative the Dimensions of Learning Project, an introductory practicum.

The second stage of the project, reported in this document, was to measure the effect of implementation of Dimensions of Learning on student thinking and achievement. This was accomplished by using several forms of assessment including videotaping, questionnaires, retention tests, application tests, and standardized tests. Results are reported in chapter six.

Throughout the implementation of the Dimensions of Learning project, teachers continued to participate on teacher-as-researcher study teams. The purpose of these study teams was teacher change relative to ideal model implementation. As teachers reached higher stages of change students were assessed on a variety of measures to determine the effects on their thinking and learning. These results were compared with similar students in control groups who had not experienced strategies from the Dimensions of Learning model or against preimplementation data from students in the experimental groups. In most cases the experimental group achieved significantly better than the control group. In some cases no significant difference was shown. In no case did the control group show better achievement.

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Chapter 1

PROBLEM STATEMENT AND COMMUNITY BACKGROUND

Background

It is generally agreed that instructional behaviors cue student thinking and, therefore, learning. Because of this relationship, there has been a major focus on the development of programs and strategies to help teachers include a variety of instructional behaviors that will, in turn, stimulate many kinds of student thinking. Although this is exciting for the practitioner who wants to enhance learning, the result in many schools across the nation has been a preoccupation with the presence or absence of specific, popular, "in" techniques. Success is measured by such things as the numbers of teachers (a) who have received in-service, (b) who can talk the language of the current programs, and (c) who can claim to have done the training for Hunter's Instructional Theory into Practice model (1982) or cooperative learning or 4MAT (McCarthy, 1980). What is often lost is that the techniques, programs, and strategies were supposed to be the means, not the end. The questions that get ignored are "What kinds of things were observed as a result of using the strategy?", "Was student learning enhanced?" and "How?"

The reason for this misplaced focus might be the ease with which one can celebrate success when the criteria are the presence or absence of specific behaviors. It is much more difficult to discuss and measure student thinking. Many attempts at defining and measuring thinking have either oversimplified and made trivial what is actually very complex or have been so abstract and theoretical that they lose practical applicability. Even with these failures, there must still be a renewed commitment to function from a clear understanding of thinking and learning so that curricular and instructional decisions are made with the student, not the staff developer, in mind. If students are not only to acquire knowledge, but to process that knowledge in a disciplined and cognitively complex manner, we as educators must increase our understanding of learning and change instructional and curricular practices to create a better match with this understanding.

The Dimensions of Learning model (see Appendix A) was used as a classification system for the various student learning behaviors that could be elicited by teacher instructional behaviors. The results of observations done in the classrooms of participating and nonparticipating teachers resulted in observation graphs; Figure 1 is one example of such a graph and shows teachers A, B, C, and D as they distribute their behaviors across five dimensions.

Teacher A represents the behavior of a single teacher whose behavior varied from the rest of the observations. The considerable amount of time spent in Dimension 1 was related to her negative rapport with students and poor classroom management skills.

Teacher B is a generalization of the observations of all other teachers and students. Note that most teachers dedicate more time to Dimension 1 at the beginning of the year, as they begin to establish classroom routines and rapport with students. Explicit observations in Dimension 1 are less obvious after the beginning of the year. In the ideal the teacher should dedicate time to assisting students in understanding how their own attitudes and perceptions affect learning.

1 = Attitudes and Perceptions

2A = Constructing Meaning and Organizing

2B = Storing

3 & 4 = Refining and Using

5 = Habits of Mind

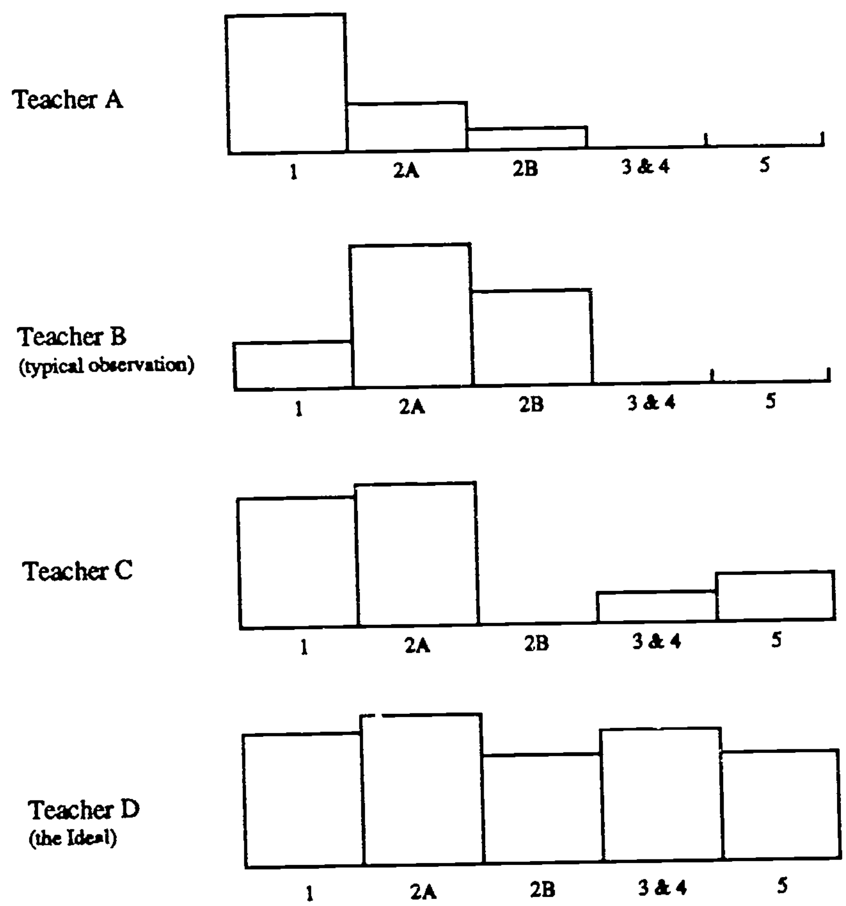

Figure 1. Time allotment of four teachers in live Dimensions' observations prior to implementation of Dimension process. (Vertical axis represents time.)

General Statement of the Problem

Classroom observations of teachers participating in the Dimensions of Learning ("Dimensions") project reveal a discrepancy between student behaviors elicited by the theoretical ideal (see Figure 1) and what presently exists.

Description of Immediate Problem Context

Willow Creek Elementary School is located in a southeast suburb of Denver, Colorado. The current enrollment is 600 students. The community is primarily composed of middle to upper-middle income families.

An extremely active, well-organized, and supportive Parent Teacher Organization provides many enrichment programs for children and adults, assists in funding program needs that cannot be secured from district and school budgets, and maintains a parent volunteer program that involves over 200 parents annually.

The school is divided into 6 grade-level teams consisting of kindergarten through fifth grade. Primary teams consist of 2 kindergarten teachers and 4 teachers at each grade level, first through third. The fourth grade team has 4 teachers. The fifth grade team has 3 teachers. Each team has an instructional/ supervisory aide. This accounts for 14 primary teachers, 7 intermediate teachers, 1 teacher respectively for art, physical education, music, media, and computer; a learning disabilities teacher, a psychologist, a half-time speech and language therapist and a half-time instrumental music teacher. There are 11 instructional aides, an office clerk, an office manager, an administrative assistant principal who is also a gifted and talented resource teacher, and a principal.

Though the teachers on these primary and intermediate teams plan together, none of them team teaches with one another. The fourth grade team has daily team meetings and ongoing communication with one another. Other teams vary as to numbers of meetings and formal and informal lines of communication. One of the four teachers in fourth grade is newer to the Dimensions program than the other three.

The fifth grade team had one new teacher in 1990-1991 and two others participated on the original Dimensions study team. The new teacher did not attend the introductory after-school sessions in 1989-1990.

A primary study team was formed in September 1991 consisting of three first grade teachers with some background knowledge of Dimensions and two second grade teachers, one with background and the other being new to the school.

After support and information gained in study teams from September 1990 through February 1991, all but one participating teacher used strategies learned as evinced by classroom observations over a two-month period beginning in January 1991. There still remained a variation in the level of use from one teacher to the next. One new teacher was not using any of the strategies in any classroom observations other than those where a unit had been planned with a day-to-day lesson plan, which she could follow. The teacher who dropped out in January from a study team continued to use habits of mind in structuring self-evaluations and learning logs for students but did not continue to reinforce them positively even when a student clearly demonstrated them. The remainder of the intermediate team consistently positively reinforced habits of mind (Dimension 5) and chose to use other strategies when they were useful in daily lessons.

Observations during planned units revealed a higher level of use of the model as a whole and approached the ideal of nearly equal attention over time to all five dimensions (see Figure 1). This held true in the observations of the primary teachers.

Students in Willow Creek were heterogeneously grouped in all teams for all subjects with the exception of reading in first and second grades. A study was conducted in 1989-1990 that indicated that most students remained grouped with the same students, with a few exceptions, for their entire elementary experience, and this precipitated the change from homogeneous to heterogeneous grouping where student groupings are changed yearly.

The staff noticed an unhealthy number of competitive behaviors on the part of students including formation of strong cliques and a lack of empathy for other students with minor differences. Teachers felt that some of the lower quartile students were experiencing greater-than-normal self-esteem problems and had few chances to benefit from the cognitive processing of the higher achieving students. After consulting a variety of research studies, the staff decided to change the school philosophy statement and grouping practice and institute some interventions such as cooperative learning groups in order to reduce the negative competitive behaviors (see Appendix B). The theme of the school became "We cooperate with others; we compete with ourselves."

All but two staff members were experienced teachers with at least five years or more of teaching experience. The program was a well-articulated basic program, but innovations had not been prevalent since the opening of the school 13 years earlier.

The principal had been in the school for five years and was preceded by principals whose styles could be classified as amiable, but decision-making tended toward either command decisions (those made by one person or subcommittee) or consultative (made by one person or subgroup after receiving information from the group as a whole). Presently, through use of staff leaders in curriculum committees and cooperative staff meetings with participatory decision-making, the leadership style in the school is changing. The staff has spent time working on a decision-making model that helps the group define which decisions need to be made as command, which as consultative, and which as participatory. The choice is situational.

In the history of the school, up until 1986 not one teacher was nonrenewed and only one was placed on evaluation. In the tenure of the present principal, a higher standard has been set for placing teachers on tenure than was experienced in the past.

Description of Surrounding Community

The community is situated near a major interstate and is close to the Denver Technological Center in Colorado. Emergency cards show that the numbers of working parents and single parents have increased in recent years. Many parents are middle-management employees of the technological center, of Martin Marietta, and of oil companies, or hold professional positions. In the recent recession, many mothers who had not recently held jobs returned to work. The numbers of single-parent families have increased in the last several years. A before-and-after school childcare program was begun two years ago.

Low minority population—approximately one percent—is the statistic reported on annual state reports. Most area dwellings are single family and town homes. Lack of diversity in the community has probably contributed to intolerance of differences in students.

Willow Creek is a neighborhood school, but large enrollment has caused the overflow of approximately 300 students to 2 schools within a 2-mile radius.

Regional and National Contexts of Problem

Since the publication of A Nation at Risk (1983), the public outcry regionally and nationally has been for school reform. The apparent desert lying between the outcry and permanent, effective instructional change is largely uncharted territory given the current expectations of the present educational system and its changing demographics. Fortunately, such attempts as What Works: Research About Teaching and Learning (1986) began to establish an initial link between public concerns and well-established educational research.

The Dimensions of Learning Model incorporates most of the findings related to classroom instruction and many others from cited sources which were not included in the What Works: Research About Teaching and Learning (1986) report (see Appendix A). The path became the restructuring of the school operation in order to facilitate teacher collegiality and learning, school climate, high expectations, and prioritized instructional support.

Keedy, Wheeler, Hartley. Rogers, and Waldrep (1989) and Joyce, Murphy, Murphy, and Showers (1989) experienced considerable success with models of teacher collaboration and peer coaching. Shanker (1986) and A Nation Prepared (1986) call for collegial relationships, reflective time, and shared decision-making, which would result in the focus on, among other outcomes, higher-level thinking on the part of students.

Two phases emerge in undertaking the task of closing the gap between the present stage of student thinking and learning and the ideal state. If instructional behavior cues student learning and thinking (Brophy, 1979), then it becomes necessary first to change instructional behavior. As instructional behavior approaches the ideal (see Figure 1), student learning behaviors should be cued which increase learning and thinking.

The first phase was to interest a group of teachers in the voluntary project, to facilitate their learning, and to maintain the application of their learning so that there was a permanent change in their instructional behaviors. As shown by the study group questionnaire in 1989 (see Appendix C), even in the early stages of implementation teachers felt that the model had some positive effects on students. Most of the concerns expressed were related to the early stage of the Concerns-Based Adoption Model (CBAM) model (see Appendix D) (Hord, Rutherford, Huling-Austin, and Hall, 1987).

The challenge was to create a structure within Willow Creek that would generate the collegial collaboration referred to by Keedy et al. (1989), Joyce et al. (1989), and Shanker (1986). This structure needed to allow for systematic and personal barriers to be minimized in order for change to become permanent. In the first six months of the introductory practicum, September 1990 through February 1991, data collected indicated that teachers had begun to understand the model and were beginning to implement some of the strategies.

The second phase was contiguous with the first, once some instructional behaviors changed, even though they might not completely approximate the ideal (see Figure 1). The problem in stage two was to see if use of Dimensions influenced pupil learning behaviors. In this stage, data were gathered in order to measure the effect of instructional behaviors on student learning and thinking. This was accomplished using a variety of measures including self-report, criterion-referenced testing, teacher observation, teacher-made testing, videotaping, and questionnaires. Further details in the next section clarify the problem.

Chapter 2

PROBLEM DEFINITION AND EVIDENCE

Problem Background

In the school year 1989-1990, initial attempts at changing teacher behavior relative to the discrepancy in the problem statement were attempted. Teachers were invited to attend study teams provided both before and after school. Attendance was on a voluntary basis.

Twenty people attended initially. Snacks were provided, and every attempt was made to make participants feel comfortable. A level of awareness was created. Certification credit was provided for those who fully participated. Initial comments were favorable. Teachers tried some of the strategies with students and reported favorable results. One person reported a negative opinion and negative results with students. He dropped out after a few sessions.

The model was in early stages of development. As a result, much of the language kept changing, and this was confusing to the group. Some people attended consistently; others flowed in and out. Feedback related to informational confusion, and high levels of personal concerns were expressed on the part of participants. Meeting times were a real barrier. This experience lead the author to the idea of restructuring the budget system and providing study teams during the working day.

Evidence of Problem Discrepancy

Using the Dimensions of Learning model (see Appendix A) as a classification for the kinds of student learning behaviors which could be elicited by teacher instructional behaviors, script-taped observations were made in all fourth and fifth grade classrooms during the 1989-1990 school year. The results of the observations are depicted by the observation graph in Figure 1. Teacher A was unique to the group. She spent a much larger block of time in Dimension 1 because her rapport with students was negative.

Teacher B represents the typical observation for the rest of the group of teachers and students. The small amount of time spent in Dimension 1 is misleading in this case. Much of the time dedicated to establishing class routines, establishing rapport, and building positive attitudes is more prevalent at the beginning of the school year. If student attitudes are generally positive, less attention is given this area throughout the rest of the year. Teacher C represents the time allotted when instances of Dimensions 3, 4 and 5 were observed. In these cases, students were engaged in such activities as problem solving or classification, but the activity focused on the process itself and had little relationship to extending the knowledge of the content being studied or using it in a meaningful way.

Further observations at all grade levels, throughout the 1989-1990 and 1990-1991 school years, confirmed the same generalized picture of the student behaviors observed in the classroom of Teacher B. Based on observations in hundreds of classrooms over many years, the author is comfortable in making the assumption that Teacher B typifies teacher behaviors in the classrooms of a large percentage of those competent teachers observed. Teacher D represents the ideal, not in one class period, but throughout the period of time that a specific body of information is instructed.

Dimension 1 thinking is the stage on which all learning is set. Research in motivation (Harter, 1982; McCombs, 1986; and Weiner, 1972, 1983) indicates that a person almost always approaches a task with a set of accompanying attitudes and perceptions that greatly influence performance. A student with a metacognitive message in his mind which says, "I hate math. I never do well. There's no sense in trying," will achieve at a lower level than a student of like ability whose message is "Math's OK. I'll ask questions if I don't understand. I'll give it my best shot." A teacher who understands this, explicitly addresses attitudes during instructional time, and teaches students metacognitive strategies that help them to maintain locus of control will have greater results in achievement.

Effective learners exhibit dispositions associated with critical, creative, and self-regulated thinking. Perkins (1984), Ennis (1985), Glatthorn and Baron (1985), Lipman (1988), and Costa (1985) cite numerous characteristics of "good thinking." Student behaviors in the ideal classroom should therefore demonstrate th se characteristics. The teacher would then dedicate instructional time to modeling, practicing, and rewarding these behaviors. A yet unpublished dissertation by a Willow Creek teacher (Chicola, in press) further documents the role of self-regulation in learning.

Prior to the beginning of this project, students could be observed occasionally demonstrating these behaviors, but they could not describe them or metacognitively articulate their intentional choice to use them. The author and the staff developer conducted video interviews in the spring of 1990 with three students from each intermediate classroom identified by their teachers as having high, average, and below-average academic progress for that year. Students were asked a series of questions such as (a) "Do you think you are a good thinker?", (b) "How do you know if you are or are not?", (c) "Do you know anyone who is a good thinker?", and (d) "What do they do that shows they are?" The responses for all groups were typical descriptions of people making good grades, or able to give correct answers to the teacher's questions. Even when probed about parents as thinkers, they responded that parents were good thinkers because they could "help with homework." A few responded with more unusual comments such as "thinkers get lots of good ideas," or "some good thinkers are artistic." Few of the behaviors described in Dimension 5 were indicated at all. One student identified for the gifted and talented program described an instance when he had been asked to read and respond to some material that was too difficult for him. This was the first time in his life that he had experienced any task that was too difficult for him to easily accomplish. The feelings he described were of panic, shame, and withdrawal. His response to this problem showed no solutions that indicated creative, critical, or self-regulated thinking. This reinforced the view that even gifted students do not necessarily develop these habits on their own.

Dimension 2 addresses how students will acquire and integrate information. The teacher must first make several curricular decisions if the presentation of the information is to match best what we know about the mind's processing of that information. A distinction should be made between declarative and procedural knowledge because procedural knowledge is practiced distributively until it becomes automatic, whereas declarative knowledge tends to be stored in images, emotions, physical sensations, and linguistically.

Because students do not come to the classroom as "tabula rasa," an attempt must be made to facilitate their construction of meaning, connecting previous knowledge and experiences to the new information. Such techniques as reciprocal teaching; what do you know, what do you want to know, and what did you learn (KWL); brainstorming; and others can assist this process.

The information must be organized in ways that facilitate learning. Organizing declarative information according to principles, concepts, and facts and providing students with graphic organizers that represent the information have proved very successful. In one social studies unit that was organized in this way, our entire fifth grade averaged 12.08 points higher on a district criterion-referenced test than in any of the other areas tested. The other areas had been organized in the conventional manner. Recognition of patterns is another strategy students might use to help organize information.

Curricula should ideally distinguish between declarative and procedural knowledge and include activities that encourage the construction of meaning, organization of the information, and storage in memory. Such strategies as mnemonics, linking, peg method, imagery, and many others are known to work and yet are rarely consistently reviewed with students in order to facilitate their storage of information in long-term memory.

Dimensions 4 and 5 relate very well to the concept of situated cognition discussed by Brown, Collins and Duguid (1989). In the ideal, it is not enough for students to acquire a body of information. If their learning situation is constructed in such a way that they can "play" with the information, extend and refine it, or use it meaningfully, then new connections should occur which relate to "real life." This thinking process is represented graphically below. In Figure 2, the student has acquired some knowledge. In Figure 3, as a result of engaging in a complex task which requires him to rethink and use the information, his initial understanding has changed.

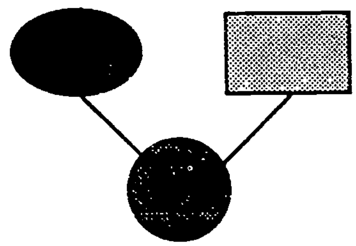

Figure 2. Learner Has Acquired Some Knowledge

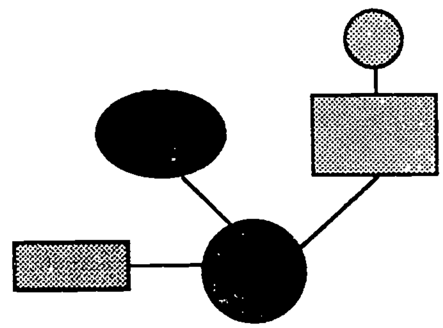

Figure 3. Learner Knowledge as a Result of Engaging in a Complex Task

Brown et al. (1989) do not specify the process used to construct these complex tasks. The Dimensions of Learning model does suggest some (see Appendix A). The instructional planning follows a flexible format in which information is acquired during a period of several days incorporating some of the concepts and strategies previously discussed. The long-term complex task is then introduced. If a new heuristic is to be employed which is unfamiliar to the students, that might be instructed. The unit of study then switches back and forth from the acquisition of knowledge to the practical use of that information to complete a complex task. Toward the end of the unit of study, more time is dedicated to the complex task.

A simple example will illustrate the process. Students are studying the Civil War. The teacher decides what generalizations, concepts, and facts are to be studied. Reading an historical map and using a decision-making model are procedural information that will also be taught. A graphic organizer is presented to help students recognize the basic generalization and concepts that they will learn. They may use this organizer to take notes or add information as the unit proceeds.

On the fourth or fifth day the complex task is presented. It may read something like this, "You are a member of a family on a border state during the Civil War. One brother has joined the northern army; another the southern. You, as the third brother are going to join one of the two armies. Use a decision-making model and work with your group to establish the criteria you will use to make your decision about the choice between the southern and northern armies. Be able to defend your decision in a debate." The group may be given structured goals to accomplish on each workshop day (day on which students work on task) or may generate their own goals depending on the level of positive interdependence or sophistication related to goal setting.

The Cognition and Technology Group at Vanderbilt (1989-1990) seem to be working toward a similar goal with their use of anchored instruction (Brown et al., 1989). The videodisc technology would certainly augment the motivational aspect for students. In both cases, students are to work through complex tasks that are specific to the generalizations and concepts of their content area, but which allow considerable flexibility so that they can generate their own problems or questions.

The ideal situation relative to the Dimensions of Learning model is theoretical, but the implementation is specific enough that its strategies can be practically applied in the classroom. Teacher D (see Figure 1) represents the paradigm shift. Given the fact that all Dimensions study-team participants were spending the large majority of their instructional time in Dimensions 1 and 2, the question became how to move through the myriad of personal, budgetary, political, and structural barriers that blocked progress toward the ideal.

To accomplish this paradigm shift interested teachers needed to understand the model and overcome issues related to change. As teachers made permanent changes in curricular practices and classroom behaviors, the task was to record those changes and to determine their effects on student achievement and thinking behaviors. The student changes were compared to behaviors in similar groups of students in two neighboring schools where curricular objectives were the same.

It was an exciting and complex task, but then the contention was that complex tasks help one to learn more about how problems evolve in the real world and encourage the kind of thinking that assists one in extending, refining, and using information meaningfully.

In 1989-1990, through direct classroom observations, this author became aware of the difficulty five out of eight study team teachers were having when a month after the initial success of trying some of the Dimensions in Learning strategies, only three teachers continued to use these strategies. The observations were followed by an informal survey. The data questionnaire (see Appendix C) shows that the majority of teachers liked the strategies and felt that students liked them, but they also had many personal concerns which they felt kept them from continuing to use the strategies.

The three teachers who continued to use the strategies asked for and received coaching from the staff-development teacher. Several months after the observations, further conversations with teachers not using the strategies included comments indicative of resistance to change such as "You should mandate these strategies for all teachers in the building," "Are we going to be evaluated based on the Dimensions Program?" "This is your and Debra's (the staff development person's) project. We really don't see that this is beneficial to what we are doing," and "Sixth graders don't want to talk about their attitudes toward accomplishing a task. They just want me to teach."

By February of 1991, a primary and an intermediate study team had been formed. Budget restructuring had allowed for half-day released time for teachers to learn and to share with colleagues information about Dimensions. Results of a six- month effort to remove some of the barriers experienced in 1989-1990 are reported in Tables 1, 2, 3, and 4.

Movement to higher levels of the Concerns-Based Adoption Model (CBAM) (see Appendix D) by individuals had a positive correlation to the more frequent use of dimension strategies except in the case where teachers were teaching preplanned units extending over a period of time. Of those teachers who fully participated, most expressed being comfortable reinforcing habits of mind (Dimension 5) in classrooms. They also felt comfortable with many of the strategies in Dimension 2. The other three dimensions were of greater concern. Classroom observations done in the spring of 1991 corroborated greater use of Dimension 5 of the model than of other dimensions.

Probable Causes of Problem

Many of the problems discussed by teachers parallel the difficulties Joyce and Showers (1988) cited in their research. Clearly, teachers were asking for more peer observations, practice sessions, modeling, and feedback.

The fact that there was no large block of time to work with teachers had been a major block to the implementation of the strategies. Teachers were trying to learn complicated information in hour blocks of time before and after school. The time available had been barely enough to introduce the information and model the strategies once. Teacher feedback recorded during study team sessions indicated that this was not sufficient. Bob Marzano, advisor to the project from the Mid-Continent Regional Educational Laboratory (McREL), also indicated that this format needed to be changed. Keedy et al. (1989) reported the same concerns from the teachers at Temple Elementary who were involved in a school improvement project even though they were volunteers just as the Willow Creek teachers were. The new study team structure alleviated some of this problem.

Fullan (1982) indicated that the complexity of an innovation has a significant effect on its implementation. Six months is not a long enough period to achieve an automatic level of implementation.

Issues expressed by teachers are parallel to concerns expressed in the CBAM model (Hord et al., 1987). Many of those teachers began at a basic level of personal concern. Movement was demonstrated in the six month implementation period. The task was to continue to address levels of concern, so that positive correlations remained between levels of concern and implementation of the model.

Lortie (1975) concluded that teachers were willing to change their behavior when they recognized a benefit to their students. If this is so, then other factors were acting as barriers to permanent behavioral changes, because there was consensus on both study teams that students benefited from this innovation. When the results are evaluated with more objective data, positive results should strengthen this belief.

Chapter 3

INFLUENCES IN THE PROBLEM CONTEXT

BEARING ON SOLUTIONS AND OUTCOMES

Influences in the Immediate Problem Setting

The budgetary procedure of providing teachers with one release day per school year was a temporary constraining factor that impeded the solution strategy of providing a systematic structure to provide time for collegial study teams. Because the staff has the decentralized authority to change this procedure, it is only a temporary constraint.

Many of the strategies in the Dimensions of Learning model involve teaching students higher order thinking skills. Standardized tests required by the district policy for assessing student progress do not emphasize higher order thinking skills (Costa & Marzano, 1988). The district policy is stated in Student Achievement Testing (November 1988), from the Office of Research and Evaluation, Cherry Creek Schools:

> All students in the third through sixth grade are required to take the Iowa Test of Basic Skills with the rare exception of those for whom testing is unfeasible. (p. IL-R)

The permanent constraint of having to use a test that does not assess skills that the staff would emphasize was a difficult one. The community values the results of standardized testing. Parents moving into the area often ask what school test scores are when considering whether to buy houses in the Willow Creek area. Each year parents expect and receive reports on the students who took the standardized tests, often making appointments with the principal or with teachers if they do not understand the results.

District leaders are taking a new interest in authentic performance assessment. If Bob Marzano is helping to design and implement an authentic performance assessment of Dimensions units, it might serve as a model as the district moves in that direction. This could be a facilitating factor, if the movement toward performance assessment is coupled with adequate parent communication. Though the intermediate study team spent considerable time working on performance assessment in 1991-1992, it took the entire year for them to experience the paradigm shift that this type of assessment represents, and they were just beginning at the year's end to see the strong connection between Dimension 3 and 4 and the development of long-term tasks for performance assessments. Change is a slow, but dynamic, process.

Teachers value students learning to think and reason as well as having the knowledge of basic content, as reflected in the school mission statement. What the district reports in terms of achievement does not reflect the value of students learning to think and reason at abstract levels (Costa & Marzano, 1988).

Examination of information provided to parents does not reflect adequate attention to this problem. In the five years previous to the Dimension project, only one article was found in newsletters that addressed the issue at all. It had never been addressed in any of the information recorded by the Willow Creek School Improvement Committee. The community's sense of high value placed on the results of standardized testing was a permanent constraint.

The expectation of having the progress of the Dimensions of Learning project reported to the Willow Creek School Improvement Committee and thus the parent community was reflected in the written goals of that committee (Appendix E) in 1990-1991. This committee consists of one nonparent, parents, teachers, and administrators. These goals were a facilitating factor. Staff members did not exhibit a common understanding of how students learn, and this was reflected in the instructional decisions they made in the classroom. This was evinced in observations made in classrooms and postobservation conferences. This lack of knowledge was a temporary constraining factor.

Teachers value student learning and thinking as shown by mission statements developed collectively by the entire instructional staff. This value is a facilitating factor.

During staff meetings, four teachers consistently responded negatively to most suggested changes other than minor procedural changes. When this occurred, the remaining staff uniformly did not respond and discussion was shut off. This had been an observable behavior for at least four years. These same four people openly opposed any proposed plan for change. The influence of these four vocal staff members was a temporary constraining factor. Two of them left. The development and use of the staff decision-making model and attendant processes have also alleviated the problem and caused everyone to have more of a voice in decisions.

The community has responded positively in private conversations with the principal as well as publicly in Parent Teacher Organization meetings to the basic goals of the Dimensions of Learning model; some community members expected reports on its progress. A group of parents participated in four learning sessions related to the model in order to help their own children at home. This class received good reviews from participants. Parent support was a facilitating factor.

The superintendent of Cherry Creek Schools had placed high value on this project by giving his support as well as by providing a half-time staff-development person as a facilitator for the 1990-1991 school year. The provision of half-time staff-development support was a facilitating factor. In return, he was also very interested in receiving hard data concerning student achievement. Given the current state of evaluation relative to student thinking, this became a constraining factor. The time factor related to the complexity of the model was another constraining factor.

Due to budget cuts, the staff-development person did not facilitate study teams in the 1991-1992 school year. The district operated at a high level of disorganization due to the restructuring of the central office, the rapid turnover in the superintendent's office (three superintendents in five years), and a budget election in November, 1991. All of these events created demands on the principal for time.

Influences in the Broader Community External to the Problem Setting

The Association for Supervision and Curriculum Development (ASCD) endorsed a national research consortium to implement Dimensions of Learning in selected schools. Representatives from Willow Creek attended this consortium in order to share information and ideas with persons from these other schools. This was helpful to our study teams as they engaged in implementation. The support from ASCD was a positive psychological factor and a facilitating factor.

The Colorado legislature strongly participated in the business of public education increasingly during the five-year period from 1987 to 1992. Legislators could not fund the education bill that they passed. Districts experienced recissions in 1991 and will likely do so in years to come. Being in a yearly position of cutting staff and budget affects teacher morale and pulls time and energy away from instructional goals.

In addition, conservatives in many communities are somehow suspicious of the "thinking" movement. The general tenor is another "back to the basics" movement that emphasizes standardized tests. So far this has not been a factor, but knowing that alternative points of view can exist can facilitate planning.

Chapter 4

PROBLEM CONCEPTUALIZATION, SOLUTION STRATEGY, AND PROJECT OUTCOMES

Review of the Literature and Consultation with Others

An extensive review of the literature was done to substantiate the theoretical base of Dimensions of Learning. References and postulates related to learning theory appear in the Dimensions article (see Appendix A).

Assuming that teacher behaviors effect student learning, the bulk of the literature review concerned itself with (a) the change process, (b) adult learning patterns, (c) the facilitation of the implementation of innovations, and (d) leadership roles in staff development.

Brophy (1979) cited substantial support for the notion that teacher behaviors effect student learning. He contends that research in this area is difficult because isolation of one or two factors for a study does not provide the gestalt necessary to determine "good" teaching behaviors versus "poor" ones. Teaching is a complex act of decision-making with regard to student needs and the content taught. His conclusion is that the processes or in the case of Dimensions, the strategies chosen and the focus that is emphasized, are related to the student outcomes.

Joyce and Showers (1988) provided research on how teachers learn, how to design effective staff-development programs, and systems for supporting teachers. Research was pulled from a variety of staff-development programs.

Fullan (1982) outlined four major needs that had to be met in order for program implementation to be successful. These include "need, clarity about goals and means, complexity, and quality and practicality of program." Because this is a complex model, it was examined from the vantage point of these needs in order to assure successful program implementation. Teachers must have a clear picture of what it is they are expected to change. Complex innovations are more difficult to implement than simple ones, but they tend to accomplish more even if they are not fully implemented. The ability to break an innovation into understandable components tends to create greater success. The quality of materials is an important factor and may have caused difficulty in the beginning stages of this innovation.

Fullan (1982) provided some help with the complexity of this innovation. He suggested breaking it into more simple components. When the model was taught strategy by strategy, teachers had a difficult time reassembling the parts. Concentrating on one or two dimensions at a time until the automatic level of learning was achieved was useful. Coupling this with unit planning in certain content areas provided the gestalt necessary to maintain enthusiasm about the entire model.

The Keedy et al. (1989, November) case study suggests that when collegial teams of teachers are brought together voluntarily during their regular working day to work on school improvement goals, the results can be successful. Some consideration is given in this study to the role of the principal and university personnel who provided support.

Achilles and Gaines (1990) supported teacher-directed change at the school site in their report on voluntary, school-based collegial teams. Administrators were involved in these teams because of the significant influence of their support. Use of released time, reduction of isolation, and increased collaboration were factors identified by Willow Creek teachers as needs.

Murphy (1986, April) provided information that helped to define the role of the principal as a change agent. Principal support and leadership in the study teams themselves was tantamount to the success of this program.

Hord et al. (1987) described the Concerns-Based Adoption Model (CBAM). This model attempts to explain the kinds of needs people have as they experience the process of change, and it suggests ways of managing an innovation successfully. Certain checklists found in the book were helpful, particularly the one dealing with the degree to which teachers are using new strategies (see Appendix D).

Hopkins (1985) outlined a simple process to help teachers do research in the classroom. The process mentioned by Hopkins (p. 33) is a simple model by Stephen Kemmis for facilitating research. It is a good organizer for the study team approach. It involves planning, doing, and reflecting on what one did. Good suggestions for easy ways to assess students are included.

Martens (1989, April) discusses frustrations and barriers similar to those experienced by the teachers in the Dimensions group. A discussion of her implementation of a new program by the study group helped to draw from its members the feelings they were also experiencing and raising problems that the group actively engaged in solving.

Hord et al. (1987) believed that teachers experienced seven levels of concern, which are hierarchical in nature, as they move toward major changes in the form of an innovation. The first level is Awareness at which point teachers tend to have a modicum of involvement or concern. This is followed by the second level, Informational at which there exists more interest in the innovation and still little worry regarding personal concerns. The teachers involved in the project at the beginning demonstrated concerns in these levels. The Stages of Concerns Questionnaire is a valid and reliable instrument that provided data about teacher growth related to Dimensions.

Two experts in the field of staff development and learning theory were consulted. Robert Marzano, the educational researcher and primary author of Dimensions of Learning, suggested that teachers would have more commitment to implementing the strategies if they were treated as professionals and became researchers in their own classrooms. The "teacher as researcher" model discussed in Hopkins (1985) also gave structure and accountability to those who were released from teaching duties to participate in study teams. More time to learn the model and discuss progress with peers was a major problem for the group. Robert Marzano was committed to the group in terms of their feedback regarding the model and made adjustments to language and structure based on their specific feedback.

The Director of Staff Development in Cherry Creek School District suggested David Hopkins' "teacher as researcher" model to give structure to group processes. She also suggested applying for recertification credit as an additional incentive for the group. This request was granted.

Planned Solution Components

Literature reviews and interviews suggested several areas of emphasis to provide support necessary for helping teachers to change instructional behaviors: (a) stages of concern; (b) adequate time for practice, feedback, and coaching; (c) training teachers to be classroom researchers; (d) collegial learning groups; (e) adult learning; and (f) structuring the implementation.

Throughout the term of the Major Applied Research Project (MARP), the goal was to have teachers become so familiar with the model that they would approach the ideal (see Figure 1). If they were able to master the use of the planning guidelines and strategies in Dimensions, the prediction was that student thinking and learning would be affected measurably. This involved several components.

Barriers related to the teachers' levels of concern had to be assessed and mitigated as much as possible so that they would want to continue to practice strategies consistently between study team sessions. The Stages of Concern Questionnaire was used at the end of the first 6 months, and at the end of the 24-month implementation period. The author monitored comments in study teams each time to note any concerns which might arise. In the results of the first questionnaire, certain people indicated a propensity for not sharing concerns. The author tried to find ways to approach these people so that their concerns could be addressed.

The difficulty with the complexity of the model suggested several strategies that were tried. After the six-month period reported in Tarleton (1991), more focus was placed on Dimensions 5 and 2 because these were the ones with which most of the group felt comfortable. This was an attempt to accomplish the divisibility that Fullan (1982) suggested. These teachers had feelings of accomplishment at being close to the automatic stage, and observations revealed their consistency of use in these two dimensions.

The use of unit planning to give teachers a picture of what instruction looks like when all areas are utilized helped determine what strategies in the other three dimensions needed more practice. Study teams used this to identify areas where more instruction was needed. Teaching of the units ensured practice.

Hopkins (1985) "teacher-as-researcher" model worked well in the first six months of implementation and was continued. More specific goal setting related to identified needs followed each study team session so that teachers could more specifically monitor their own progress. Another way to do this was to focus only on language arts instruction so that teachers had a clear picture of what Dimensions looked like in a single curricular area. This was intended to create divisibility and also match with the school goal to improve reading instruction.

Lortie (1975) suggested that teachers will be more willing to continue to use an innovation if they believe that it has positive effects on student learning. Two classrooms in which the Dimensions units were taught were videotaped in April of 1991. The results were to have been analyzed over the summer and presented to teachers in September of 1991. This did not happen until the summer of 1992 and therefore did not contribute to teachers' beliefs about the positive effects of the innovation.

Student interviews took place in 1990-1991 and 1991-1992 in order to determine student growth in Dimension 5. Performance assessments following units were not matched with performance assessments in classrooms where Dimensions strategies were not employed because development of good performance assessments took much longer than predicted and will continue into the 1992-1993 school year. Instead, retention and application tests, which were more traditional, were used to gather data. This gave teachers and the district more specific feedback as to student growth.

MARP Outcomes

Terminal Objectives

After the consistent use of Dimension 5 by participating teachers, students in their classrooms will show growth in identifying and demonstrating habits of mind as evinced in sample surveys and classroom observations.

After participating teachers' consistent use of unit planning and Dimensions 2 and 5 in their classrooms, students in those classrooms will show more specific long-term retention of information taught as evinced by posttests.

Process Objectives

After the personal interaction and support of research study teams from September 1990 through December 1991, study team members will show evidence of reaching levels 5 and 6 of the CBAM (see Appendix D) related to concerns in Dimensions 2 and 5.

After the personal interaction and support of research study teams from September 1990 through December 1991, study team members will show evidence of moving up on the CBAM (see Appendix D) related to Dimensions 1, 3, and 4.

After support and information gained in study teams from September 1990 through February 1992, participating teachers will demonstrate an automatic level of learning of strategies from Dimensions 5 and 2 as shown by classroom observations spread throughout the implementation period, February 1991 through June 1992.

After unit planning in study teams from April 1991 through June 1992, participating teachers will demonstrate the ability to plan units focused in specific content areas independently and will include all five dimensions in those unit plans.

Chapter 5

HISTORICAL ACCOUNT

Introduction

This project was designed to create permanent instructional changes within a group of volunteer teachers. The change would approximate the theoretical ideal described in the Dimensions program (see Appendix A and Figure 1). These instructional strategies were designed to cue student thinking and learning behaviors described in Dimensions (see Appendix A).

The first step was to develop an implementation plan that addressed many of the barriers to change preventing the group from continuing to use the strategies to which they had been introduced. The systematic plan for staff development had previously been restricted to before- and after-school study groups primarily on teachers' own time and an occasional staff-development day or afternoon when students were not required to attend school.

The Dimensions model was far too complicated to be understood and practiced in such a time frame. The staff-development system was restructured by changing the budgeting process, informing the community about the importance of staff development related to the project, arranging for some consistency in use of the same substitute teachers where possible, and acquiring additional funding by writing grants. In the introductory practicum from September 1990 through February of 1991, results of classroom observations and a CBAM survey indicated that some progress had been made toward teacher change related to the model and its strategies. This change did not approximate the ideal enough to affect student learning behaviors at that point in time.

The second step was to develop study teams that efficiently used the time available and that required accountability on the part of team members for implementation and feedback. The Hopkins (1985) "teacher-as-researcher" model was employed. The third step was to measure permanent change on the part of the teachers using classroom observations and the Stages of Concern Questionnaire.

As permanent changes were demonstrated, student behaviors were measured using a variety of instruments including (a) self-report, (b) surveys, (c) teacher/ student interaction analysis from videos, (d) criterion-referenced tests, (e) interviews, and (f) unit posttests.

Prior Activities to MARP Implementation

From September 1989 through May 1990, informal study teams met before and after school to learn the strategies of the Dimensions model. The groups were strictly voluntary. Feedback on areas of need and reactions to the strategies they had tried are reflected in the study group questionnaire (see Appendix C).

At that time the study group was working with Bob Marzano from the MidContinent Regional Educational Laboratory (McREL) to assist in the development of the model by giving suggestions for clarifying language, modifying strategies, bringing up developmental issues, and giving other appropriate feedback. Implementation was particularly difficult because the model was not yet refined.

In 1989-1990, the superintendent showed particular interest in the development of the model in conjunction with McREL by allowing a half-time staff-development person from Cherry Creek School District to be placed on the Willow Creek staff that year to work on the project. The superintendent left the district that year.

In May of 1990, the author and the staff-development person met with the new superintendent to advise him of the objectives and the previous progress of the project. He was interested enough to extend the staff developer's half-time contract for the 1990-1991 school year, but requested hard data relative to the impact of the program on students. Teacher report and journal keeping related to the "teacher-as-researcher" model proposed for study team were not considered sufficient data. This put pressure on the author and the staff developer to provide some objective evidence of student progress even before it could be demonstrated that sufficient permanent change had been made on the part of teachers.

In the summer of 1990, budgeting procedures were finalized in order for substitutes to be provided for study teams. Bob Marzano provided changes that made the developing teacher manual more understandable and created a lesson planning format and workshop approach for implementation.

Planning and Implementation: August 1990-January 1992

The implementation of this plan included (a) altering of the budgeting procedures, (b) planning and implementing study team meetings twice monthly from September through February 1991 and approximately every three weeks from then until June 1992, (c) generating various communications to parents related to Dimensions, (d) designing and using a "Dimensions" report card,

(e) attending four ASCD research consortiums, and (f) providing demonstration lessons as needed. Various kinds of student data were collected in classes where observations determined that a particular teacher had mastered a sufficient number of instructional strategies in order to influence a change in student behaviors related to the model.

There were two major changes in the plan's implementation. The original data reflected members of the three intermediate teams. One person dropped out before implementation began in August. Two new people were added to the intermediate study team. One had not participated previously, but had been in the building; the other was new to the staff. The most significant change was that five primary teachers wanted to form a Dimensions study team in the fall.

Five other primary teachers formed a Literacy Plus study team. Literacy Plus is a reading, writing, and vocabulary instructional program written by the developers of Dimensions. It includes strategies from the Dimensions program that are most applicable to language processes. This study team was to have been facilitated by a staff developer and coauthor from McREL. In November, McREL's grant configuration changed, and she was not able to continue to facilitate this group. The author, being the only resource person at Willow Creek knowledgeable enough to facilitate this group, took over responsibility for its progress as well.

With two Dimensions study teams, the author split the responsibility for planning with the half-time staff-development person who then took the more experienced intermediate study team. The author took responsibility for the inexperienced primary team because the author had the primary teaching experience and the staff-development person did not. In August the staff-development person went on parenting leave through October. She came for study teams but was not available to the intermediate people for demonstration lessons and coaching on a daily basis.

August 1990

On August 16 and 17, the author met with the intermediate study team to plan for the coming year. The two newest members were not present for the meeting nor was the staff developer. The fifth grade teachers agreed to work on a report card that incorporated habits of mind and brought attention to other components of the program. Both fifth and fourth grade teachers agreed to emphasize habits of mind at the back-to-school night in September by working with parents to make them aware of habits of mind and involving them in setting goals for their children for the upcoming school year.

Some strategies in Dimensions 3 and 4 were reviewed and others were added to the agenda for future meetings. Both groups agreed to use Voyage of the Mimi I and II, an interdisciplinary unit that depends on the integration of computers, as a vehicle for trying the Dimensions strategies they had previously learned. Considerable time was spent going through the manual determining where Dimensions strategies were most appropriate for instructing the content.

On August 22, the author met with the primary study group. They began a review of the habits of mind and decided which one they would emphasize in their classrooms before the next study team meeting. One member was new to the school and others presented their perceptions of the Dimensions program and why they were interested in forming a study team this year.

Comments indicated that they were at Awareness or Informational stages of concern (see Appendix D).

September 1990

On September 14, the author met with the primary study team. Teachers reported working on restraining impulsiveness with students. One member was working on "thinking about your thinking" with her students. The group reviewed an overview of the entire model and the purpose for each dimension. The group practiced some Dimension 1 strategies to use in the classroom.

On the same day, the author observed the intermediate study team in the afternoon. Members felt good about the back-to-school night conferences with parents. Fifth grade teachers worked on the report card. Teachers expressed concern about not enough time to plan the Voyage of the Mimi unit and about lack of expertise to do so. The staff- development person promised to put a unit together for teachers to work through as a model for future units.

October 1990

On October 12, the author met with her study group to follow up on the Dimension 1 progress and habits of mind. Self-regulated habits of mind were discussed and added to the "will try" list.

In Dimension 2, strategies KWL, brainstorming, and reciprocal teaching were demonstrated. Discussion ensued as to how they assist students in acquiring and integrating knowledge. Each person decided what to do before next time. The rest of the group who had some background with the Dimensions model assured the new staff member that it was all right to feel confused and overwhelmed. The author used this as an entrée into a discussion about the case study of the teacher who had implemented the new science program (Martens, 1989). A discussion of personal concerns seemed to help the members express feelings.

On October 12, the intermediate study team met with the staff-development person. The author attended a district meeting and missed that team session. Members of the team came to the author individually to complain that the study team agenda was beginning to look like it reflected the needs of the staff developer rather than those of the team. The author discussed this with the staff developer. A plan was suggested.

On October 25 the fifth grade worked on the new report card. The fourth grade worked on a science unit to teach as a team. The author gave input into the discussions related to the report card. The staff-development person worked with the fourth grade to develop a unit on the solar system using all of the five dimensions.

November 1990

On November 7, the author met in the morning with the primary study team. They shared successes with the habits of mind strategies and Dimension 2 strategies, and discussed revisions in reciprocal teaching. Examples of student behaviors were shared. A format for planning units was introduced. An example of planning a simple primary unit was demonstrated to the team. The team worked together in grade-level pairs or triads to begin to develop their own units. The author worked one-on-one with the new staff member and assisted each small grade-level group. The result was a unit that could be tried in the classroom. First grade worked on a space unit. Second grade worked on a unit related to ranching.

The author could not attend the meeting of the intermediate study team again due to district meeting conflicts. Intermediate team members voiced complaints after the meeting that though units were beginning to be written, they were being done so that the staff developer could get student assessment results rather than being dictated by the group needs. The author met with the staff-development person about some of the concerns expressed.

December 1990

The intermediate study team meeting on December 6 was more interactive; members discussed units in progress and gave constructive feedback. The staff-development person had been back from parenting leave and in the building working with team members for over a month. She had been supplying them with materials and suggestions for new units. She had been doing model teaching in the classrooms.

The primary team members expressed the view that they were better able to put the pieces together by building units and receiving feedback from the author than by concentrating on individual strategies. If a review were needed, the team would stop and work through the strategy and then return to the unit planning. Feedback in December focused more on the impact of the units on students and on management concerns, than on learning more strategies.

January 1991

On January 17, the primary study team met to discuss the results of their units. The latest social studies unit, which had previously been a study of Mexico, had resulted in a study of how people adapt to their environments. The culminating activity required the students to create a decision-making matrix with criteria to help them decide where among several places in the world they might choose to live. The first-grade teachers were amazed that their students were capable of performing complex processes at that grade level.

The second-grade teachers had mixed reviews on their health unit but were very pleased with the new strategy for helping students store concepts in long-term memory by involving them in "vocabulary theater." One teacher felt that the concept attainment method for introducing a lesson worked well to help students clarify a concept, and it was motivating.

A principal's meeting pulled the author out of the afternoon intermediate meeting. One member of the intermediate team had dropped from the study team because of conflicts between the subject matter of the units being developed by the team and the units she needed to produce due to receiving several innovative grants. The rest of the team was working individually on fourth and fifth grade science and social studies units appropriate to their own grade levels. These included Colorado history, the American colonization, the universe, and ecological systems.

February 1991

On February 1, the primary team met and reviewed strategies from Dimensions 1 and 5. The self-critic strategy was demonstrated, and examples were generated from the team members' personal experiences to introduce creative habits of mind. Other obligations again prevented the author from staying for more that thirty minutes of the intermediate team's session.

On February 8, 9, and 10, the author, staff developer, and a teacher from Willow Creek attended the ASCD consortium in San Francisco. The teacher produced a report for the consortium which reported her involvement in Dimensions 2 and 5 (see Appendix F). Her report, as well as those of others at the consortium, revealed positive examples of the effects on students. The reports were shared with the remainder of the study team members.

March 1991

No study teams met in March. It had been announced that the school was going to undergo a major remodeling project over the summer, and time was dedicated to finalizing blueprints and plans for packing and moving everything in the building by the last day of school when demolition teams would arrive.

The author demonstrated the self-critic strategy from Dimension 1 in all four of the second grade classrooms. Observations were made in all classrooms of members of both study teams and individual postconferences focused on Dimensions strategies.

One of the fifth grade teachers had been working on her dissertation topic, dividing her math students into heterogeneous cooperative groups. Her purpose was to test the best combinations of Dimension 1 and Dimension 5 self-regulated strategies. One group was given regular instruction in math problem-solving techniques and served as the control. Group 1 was given regular instruction along with additional instruction and practice with attitudinal strategies (see Appendix G) related to improving positive attitudes related to math problem solving. Group 2 was given regular instruction along with task strategies (see Appendix H) related to metacognitive goal setting and self-regulation. Group 3 was given the same math instruction along with the attitudinal strategies paired with the metacognitive goal setting and self-regulation strategies. Both of us had hypothesized that the third group would show the best growth. As we conferenced about her findings, it became clear that the second group showed significant growth over the other two categorical groups (see Appendix I).

This deviated from our original prediction that attitudinal strategies paired with the metacognitive goal setting and self-regulation strategies would produce the strongest results. We did not know whether all groups had been contaminated by instruction earlier in the year concerned with attitudinal strategies or whether the success factor built into the concentration of time on metacognitive strategies created the difference. Results confirmed the importance of including self-regulated task behavior along with math problem-solving instruction. Although the sample was only 82 students, the instruction could be controlled by having all of it done by one person. This study, Chicola (in press), is well worth replicating.

Observations and postconferences with three out of the four fourth-grade teachers revealed competency with strategies in Dimensions 1, 2, and 5. In Dimension 3 they were most comfortable with classification and comparing. In Dimension 4 they were most comfortable with decision-making. Most still admitted that without planning an entire unit that forced them to include complex tasks in Dimensions 3 and 4, their inclination was still to revert back to Dimensions 1, 2, and 5 for everyday instruction.

This was progress. Students were consistently using the language of the habits of mind and pointing out when either the teacher or other students were demonstrating these behaviors. This was happening whether the observation was announced or unannounced. The fourth teacher was not employing the strategies except when she was instructing a science or social studies unit that had been planned by the team; even then, Dimension 5 was not reinforced with students.

Science and social studies units planned by the team were consistently incorporating the combination of time related to the ideal. These units were taking from 6 to 8 hours to plan, but once planned, teachers remarked that they were easy to instruct, and they felt that they were increasing the students' abilities to store information in long-term memory and their abilities to make new connections using the learned information.

The primary observations and postconferences revealed almost identical information. Teachers were also experiencing difficulty in modifying many of the strategies in Dimensions 3 and 4 so that they could be appropriately taught at primary. It was more a question of the amount of time it would take for the group to work together to do so than a belief that these strategies were developmentally inappropriate for their grade levels. Two of the primary teachers were less consistently reinforcing the habits of mind in announced and unannounced observations than the other three. Students in these classes demonstrated fewer instances of these behaviors than in the other three classes, during observations in December 1990 and January through March 1991.

April 1991

On April 4, the intermediate study team met. The discussion was around the new unit planning format developed at the February consortium. The teacher representative from the consortium took the group through the format while beginning to develop a new unit for their team. Members brought resources for a Colorado history unit, and the group worked together using the form as a tool.

The group discussed the possibility of involving the entire staff next year in implementing habits of mind (Dimension 5). They agreed that this would be advantageous for all students and not difficult to implement with staff as a separate element. The best approach for introducing it to staff seemed to be testimonials. The group was willing to share its own experiences with the rest of the staff.

The group decided how data were to be collected relative to student growth. One fourth grade teacher and one fifth grade teacher consented to being videotaped doing several lessons. These videotapes would be analyzed by an outside evaluator from the University of Northern Colorado along with two videotapes of excellent teachers from a neighboring school with students comparable to those in Willow Creek as related to standardized test scores on the Iowa Test of Basic Skills (ITBS), socioeconomic status, and ethnicity.

The entire group would supply responses to questions related to specified science and social studies units dictated by district curriculum in astronomy and American colonization. Two other schools with comparable student populations agreed to supply written responses to the same questions from their students.

The group began to discuss ways of building in better assessment of students. Performance assessment was discussed. The group decided to investigate more about the assessment issue and to consult with Bob Marzano about providing some assistance.

On April 12, the author observed one primary study team teacher to provide her with feedback on a unit she was trying. That same day, the author did a three-hour presentation at Holly Hills Elementary School, because teachers there were interested in hearing more about the Dimensions project.

On April 16, the author did a follow-up observation with the same primary teacher. Modifications were discussed to improve student responses. That afternoon the author met with the entire first grade team to set the agenda for the next primary study team.

On April 18, the primary study team met and worked through the new planning format in connection with a new unit. Teachers also discussed the comparison between Dimensions and the Literacy Plus program and were astonished by their understanding of the development of that program as it related to the Dimensions model.

Each teacher planned her own reading/writing unit using elements from the five dimensions and additional strategies from the Literacy Plus program. (Bob Marzano had developed the Literacy Plus program.) Literacy Plus is a literature-based program with a whole language approach. Strategies in the program match strategies in Dimensions 2, 3, and 4 of Dimensions. They are directly related to the reading/writing process. Group members brought in literature that they intended to use with their students and examined various books to determine which strategies best matched those needed by students and which were emphasized by the literature chosen.

The group also worked on a restructuring idea for reading instruction in the school year 1991-1992. This involved using the learning disabilities teachers and the specialist teachers (physical education, art, media, and computer teachers) to pull out half of their students during the first two half-hours of the day. The special teachers would be initiating a reading enrichment program with half of the students in first and second grade while the first and second grade teachers could work with small groups of students in reading.

Students would be identified for these groups as early, emergent, and fluent readers and would concentrate on semantic, syntactic, graphaphonic, and metacognitive strategies that would improve their reading abilities. The groups would be flexible and have the advantage of as near to one-on-one instruction as possible. This structure had three main purposes: (a) to provide early intervention so that all students would be on grade level or better by third grade, (b) to create a love of reading in students, and (c) to make sure that heterogeneous grouping of students for reading and writing was occurring for the rest of the school day, thereby eliminating the basal reading groups.

On April 26, both intermediate and primary study teams met. The intermediate team met without the author to continue the work begun at the previous meeting. The primary group met to discuss issues related to preassessment of the first and second graders in the fall and agreed to use Marie Clay's Concepts of Print for early or non-readers, a Slingerland test for graphaphonic skills, a reading record to determine strategic strengths and weaknesses, and a reading inventory. Students would be assessed after the first two weeks of school on a one-on-one basis. Learning disabilities teachers would assess students whom kindergarten teachers had identified as being possibly at-risk.

Considerable time was spent making decisions about logistics. Would students this young be able to move throughout the building quickly and in a manageable way? Was 30 minutes enough for each group? How could the specials teachers be brought into the process? How could we help those members of the first and second grade who had not been teaching strategies to understand the difference between skills instruction and reading strategies related particularly to Dimension 2? These and many other questions occupied the team's time.

For the first time, teachers who had not been on the Dimensions team met with those who had been working on the Literacy Plus study team. The difference in the two groups was that though the Literacy Plus group had an understanding of some of the strategies in the program, they had little to no understanding of how they encourage students to do higher order thinking, to organize information, to construct meaning, or to store information in memory. Not knowing this information themselves, they were certainly not able to articulate this to students. The Dimensions study team could clearly understand why the strategies were included in the Literacy Plus program because of their theoretical background.

On April 29, the author observed one of the primary teachers to give feedback on the literacy lesson planned in study team. Students showed evidence of habits of mind in restraining impulsiveness, in planning, and in being sensitive to the feelings and level of knowledge of others.

May-June 1991

On May 23, the author observed in the classroom of one of the primary teachers to give feedback on a literacy lesson. Informal lunch meetings were held with both intermediate and primary study team members to finalize goals for next year.

Posttests were gathered in the Willow Creek fourth grade and the matched school's fourth grade related to the circulatory system and the solar system. Fifth grade tests in both schools were gathered related to colonial America.

Much of May and June was spent preparing to pack, label, and move every piece of equipment and material in the entire building in preparation for summer remodeling.

July 1991

In the last week in July, ASCD held the last research consortium in Boulder, Colorado. All fourth grade members of the intermediate study team attended along with two members of the primary study team. Discussions centered around assessment, grade-level examples, unit planning, and general sharing of experiences. Many people favored the unit-planning method as a way to insure that the five dimensions were included in their teaching.

August 1991

The intermediate study team met on August 22 to work on unit planning for the new year. They also saw a need for investigating new assessment tools that would assist in gathering data about student progress related to learning/thinking. This was set as a goal and the remainder of the time was spent developing a new social studies unit planned with the unit planning guide.

The primary study team which now consisted of people who were in the Literacy Plus study team and the Dimensions study team worked on the details of restructuring how and when reading and language instruction would be delivered in the school. Some members were still confused about the difference in strategy-based instruction and skills instruction. A plan was developed, along with some preassessment tools that the groups agreed to use.

September 1991

On September 5, the primary group met again after having tested the first and second graders. Problem areas were discussed. Students were classified as beginning, emergent, and fluent readers. Strategies were identified to help improve the reading for each group. Dimension 3 and 4 strategies were to be included for each group. There was far less understanding of the necessity of using Dimension 3 and 4 strategies from those teachers who had not been on the original Dimensions study team than from those who had been.

On September 13, both primary and intermediate study teams met. The intermediate study team had a presentation on performance assessments from the district director of curriculum and instruction. The primary team continued to work on the issues raised at the previous meeting. The author observed two intermediate study team members and provided feedback.

In the last staff meeting of September, members of the primary and intermediate Dimensions study teams gave testimonials to the staff related to habits of mind. They proposed that the entire staff begin to introduce and reinforce habits of mind in their teaching. By consensus, the staff decided to implement habits of mind school-wide for the 1991-1992 school year.

October 1991

The author met with Bob Marzano, the primary developer of the Dimensions of Learning program, on October 10 to discuss reading assessment and performance assessments related to Dimensions. He had developed standard rubrics for each area of Dimensions 3 and 4 to be used in performance assessments of these areas. On October 11, the author gave a habits of mind workshop so that teachers who were unfamiliar with the habits of mind could begin to include them in their teaching.

During October, five observations were made of teachers in Dimension study teams. With the exception of one class, students showed an understanding of some of the habits of self-regulated learning. In observations of other classrooms, little evidence was seen of instruction of habits of mind.

On October 25, Monte Moses, Director of Curriculum and Instruction, met with the intermediate study team to discuss implementation of performance assessment. The team agreed to try a performance assessment designed around a research project. Students were asked to ask a thoughtful question that they wanted to answer, to research the question, and to develop a visual, oral, and written presentation in two days. Part of the performance standards was working in a self-regulated manner. Teachers were to play the role of coach and evaluator. The team agreed that the fifth grade teachers would try this with their students first and then provide feedback to the fourth grade teachers.

On October 28, members of the intermediate study team met with the learning disabilities teachers and the media specialist to make some decisions about the students in the learning disabilities program. They decided that the standards for the performance assessment would remain the same, but that the learning disabilities teachers would provide the coaching for these students.

Observations were made this month of four teachers on intermediate and primary study teams. Updates regarding progress of the staff in implementing habits of mind were done in two staff meetings.

November 1991

Parts of two staff meetings were dedicated to progress on habits of mind. The fifth grade teachers conducted their first research performance assessment. The primary team did not meet. A team from ASCD interviewed the author and all members of the original Dimensions study teams to determine their individual reactions to the model. Comments were positive and teachers were able to give specific personal examples of the effects of the model on their students.

December 1991

On December 11, a video team from ASCD taped in classrooms of two members of the Dimensions study teams, one primary and one intermediate teacher. The tape will be produced by ASCD for distribution in fall of 1992.

Four observations were conducted by the author in classrooms of study team members during December. Several staff members not involved in the Dimensions study teams asked for demonstrations of introducing habits of mind in their classrooms.

On December 19, the intermediate study team met to discuss the results of the first performance assessment. Much discussion ensued related to students with learning disabilities. The decision was still to remain firm with the same standards for all students. There was much discussion about how to make improvements in the process. The third grade teachers, who had not been involved previously, were invited to attend. Grades three through five agreed to try their own versions of the performance assessment and meet when they were finished to discuss the results.

The author had interviewed an entire classroom of students in the third grade last year relative to habits of mind. This class had no prior exposure to "habits" and the answers to the questions were indicative of no exposure. This group was evenly distributed to four classrooms in the fourth grade. The author reinterviewed the same students to determine if there had been a change in their responses. Results are discussed in Chapter 6.

January 1992

On January 10, the primary study team met to discuss progress. Some of the members decided to use new reading materials which would facilitate the strategy instruction. Three team members were still confused about the role of skills related to strategy instruction. Teachers taped all students who were still considered deficient in reading. The group analyzed each tape for strategies that were lacking and gave each other suggestions. Many suggestions centered around metacognitive problem-solving in reading. A date was set for another meeting when the new materials would be available.

On January 13, the intermediate study team met to refine the standards and rubric for the intermediate performance assessment. The team decided to delineate each habit of mind separately on the 1992 standards rather than just stating, for instance, self-regulated behavior.

The author spent an afternoon at Evergreen Junior High introducing a group of teachers to the Dimensions model. They were interested in pursuing it as a planning tool for improving thinking skills for at-risk students. The author continued to observe in classrooms of teachers on the study teams to provide feedback.

February 1992

The author conferred with Charles Fisher, the Dimensions program evaluator, about his progress. He had not completed his analysis of the videotapes, but indicated preliminary results were positive. The author met with Bob Marzano, the primary program developer of Dimensions, to assist in blind scoring of some of the posttests from last spring.

The School Improvement Committee met to review all testing results for Willow Creek including results from some of the Dimensions data. A goal was set for the 1992-1993 school year to coordinate an effort between parents and teachers around habits of mind (see Appendix J). Observations of study team members continued.

March 1992

On March 11, the intermediate study team met to discuss the results of the second performance assessment. Third grade team members made significant modifications in their process and divided the tasks that students would perform into three distinct mini-tasks, because students were experiencing difficulty with the complexity of the original task. Teacher observations continued.

April 1992

The primary study team met on April 8 to decide about end-of-the year evaluations of student progress and record keeping. Plans were developed for the 1992-1993 school year. Materials had not arrived, so an in-service date was set for May.

The intermediate study team met on April 30. Members discussed the paradigm shift that the complex performance tasks had made relative to their teaching. One teacher summed it up in an analogy. "I took a sailing class once. I scored extremely high on an on-shore test related to sailing. It was a very different matter when I was in the middle of the lake and had to right an overturned sailboat. I think this is the experience we and our students are having with performance assessment."

The group agreed that because teachers had no clear standards for writing, students probably did not. The task was to gather excellent examples of student writing at each grade level and to use these to develop a rubric and standards for writing for the 1992-1993 school year. A performance assessment task had been developed for students previously, but standards were not clear enough that students could self-regulate their progress. A meeting time was set for May to begin that task.

May 1992

The author met with Bob Marzano, the Dimensions program developer, to finalize the results of the previous assessments. Students on the fourth grade team were given the math concepts subtest of the Iowa Test of Basic Skills to determine if there was a significant difference in these scores in classrooms where Dimensions strategies were taught as opposed to those where they were not.

The intermediate study team met May 15 to work on standards and a rubric for the writing performance assessment. The primary study team met for an in-service related to new literature materials and also worked on the same writing goal that the intermediate team was working on for the 1992-1993 school year.

Students in the fourth grade were given the math concepts subtest of the ITBS. Results were analyzed to see if differences existed between groups who have teachers using Dimensions strategies and those who do not.

June 1992

The author spent this month doing a final analysis of the data and planning for the next year. Fortunately, there were no plans for remodeling the building again or restructuring the central administration. The CBAM questionnaire was readministered to some members of the primary and intermediate study teams who had originally taken it.

Additional Practicum Activities: 1990-1992

On August 21, 1990, the author met with Bob Marzano and Charles Fisher. McREL would provide the funding for Charles Fisher, a researcher from the University of Northern Colorado, to videotape two classrooms at Willow Creek and two at a school with a similar population of students. The subject matter would be similar since both schools were required to teach the district curriculum. Charles Fisher's job was to analyze the data to determine if there were differences in student behaviors or student/teacher interactions between the classrooms where Dimensions was implemented and those where it was not. The decision was made to do this as close to the end of the school year, 1990-1991, as was feasible in order to provide teachers with as much time as possible to make some permanent instructional changes. On September 5, the staff developer and the author met with Bob Marzano to discuss various forms of assessment including performance assessment. He had received a federal grant to develop a model for authentic assessment and thought that Dimensions could provide a framework if the school could supply the content and expertise of student capabilities at various grade levels. The staff developer and the author used this time to update each other on the progress of both teams and to confer on directions for the future. The staff developer agreed to lead the next intermediate study team.

On September 6, at the large meeting of all parents and teachers, the author introduced the concept of habits of mind and demonstrated the usefulness of a particular one by doing a short participatory activity involving the entire group. In weeks to follow the author received many positive remarks. One new parent shared that it was the best back-to-school night he had ever attended (see Appendix K).

On September 12, the staff development person and the author met with the assistant superintendent and two area directors to update them on the progress of the project and to remind them that they had promised in the spring of 1990 to fund the attendance at the ASCD consortium. Somehow this had slipped everyone's mind. The district was in the middle of the second major restructuring in three years and the third superintendent in three years.

On September 20, the author turned in her performance objectives to her new area director. Objectives related to Dimensions were included.

On October 19, the School Improvement Committee met. A report was given about some of the work on Dimensions which had happened the previous year. Two goals in the new plan related to the Dimensions program (see Appendix J).

On November 9 and 10, a fourth grade teacher, the author, and the staff-development person attended the first ASCD consortium in Boston. Each person worked with a different group. Improvements were made to the teacher's guide and lesson planning format. Group discussions clarified elements of dimensions 4 and 5. This work was brought back and shared with study teams.

The School Improvement Committee met to finalize the goals on November 16. Dimensions was included as a pilot because of the author's concern that many parents were beginning to ask why their child's teacher did not reinforce these areas. Because the program was strictly voluntary, this helped to answer that question.

Teachers who had volunteered to be control classrooms for student assessment met with the author on November 27 to discuss the details. Some difficulty existed about the disparity of time spent from one school to the next on particular objectives.

The superintendent visited Willow Creek on January 25, 1991, in the morning. He met with fifth grade students who told him about establishing criteria for critique of their own art work. He saw a fifth grade team converted by 30 computers to a command station and spaceship for a moon launch. He met together with the fourth grade team to discuss members' impressions of the impact of Dimensions on their own teaching.

The ASCD consortium met in San Francisco February 7-9, 1991. The people who had attended in Boston returned. Teams from all over the country gave feedback about format, strategies, vocabulary, graphic organizers, and other components. People shared experiences about students, frustrations, and successes. The information was again shared with study teams. New materials developed at this meeting were also distributed.

In February and March, arrangements were made with other schools that would serve as control populations for the videotaping and the posttest assessments. These assessments took place in March and April, 1991.

The final meeting of the ASCD research consortium took place in Boulder, Colorado in July of 1991. This allowed many of the members of the study teams to attend the consortium for the first time. They were acknowledged for their work and were able to participate in the final revision of the program materials.

In December of 1991, ASCD sent a videotaping team to Willow Creek to tape interviews with the Dimensions participants and to tape student interactions in their classrooms. In April of 1992, the rough copy of the videotape was shown to the Willow Creek School Improvement Committee and teachers and students who participated. The final copy will be out in summer of 1992.

Classroom Support and Demonstration Lessons: 1990-1992

Requests for demonstration lessons were more prevalent in the early stages of the project than in fall of 1991. In the 1990-1991 school year approximately 10 requests per month were made. In the fall of 1991 fewer than 3 requests were made per month.

During the 18 months of implementation, January 1991 to June 1992, observations were made in the classrooms of both intermediate and primary study team members. Formal lessons were script-taped; pre- and postconferences were conducted. Much of the content of the postconferences centered around the Dimensions model and its positive or negative effect on students. Informal observations were also made where the author would not spend an entire class period in the classroom. Informal lessons did not include preconferences, but did include postconferences if feedback seemed appropriate at the time.

Some requests for demonstration lessons came from staff members who were implementing habits of mind for the first time, but had not been on the Dimensions study teams. This was natural given their awareness level stage of concern.

Parent Communication and Reporting

A series of 15 articles giving suggestions to parents about things they could do to encourage habits of mind at home was sent home in the school newsletters at the rate of one per week over the first semester of 1990 (see Appendix L). These articles were repeated in newsletters in 1991-1992. No data were gathered as to the effectiveness of this strategy. Six positive comments and no negative comments were made to the author regarding the articles. In the author's experience, that is a high rate of comment for a noncontroversial topic. Four parents called, asking for information which they could share at their places of business.

The fifth grade team surveyed parents at the March 1991 parent conferences to determine if they had liked the inclusion of the Dimension 5 components on the report card. Three negative comments were registered out of 86 parent conferences.

Dimensions was a topic for the fall 1990 and 1991 back-to-school nights. In spring of 1992, the Willow Creek School Improvement Committee put together a plan for fall of 1992 that integrated the introduction of habits of mind in the classrooms with parent classes, information about what to do at home, and a publicity campaign to synchronize efforts at home and at school. This was written into the updated plan (see Appendix J). In spring of 1991 and also in the spring of 1992 the committee received reports on the progress of the Dimensions project. The committee was impressed with the initial student assessment data and encouraged collection of further data in the 1992-1993 school year.

Chapter 6

EVALUATION OF RESULTS AND PROCESS

Background

This project was accomplished in two stages. Each stage had its own terminal and process objectives. Stage I concentrated on the elimination for teachers of barriers that prevented them from permanently changing their instructional behaviors related to the Dimensions model. This was the focus of the first six months of implementation though it continued to be an objective throughout the entire implementation. Though the terminal and process objectives for Stage II focused on student learning and thinking, the objectives for Stage I continued because the needed level of teacher change had not occurred. The Concerns-Based Adoption Model (CBAM) instrument was used to measure Stages of Concern (SOC) in the early implementation of Stage I. Direct observations in classrooms determined the extent of implementation relative to the model. Observations continued throughout Stages I and II. The SOC was given again at the end of Stage II.

Stage II focused on student change related to thinking behaviors and achievement. The assumption is that student behavior is related to teacher behavior (Brophy, 1979), so those teachers who were more successful in approximating the theoretical ideal (see Figure 1) should have better student results. One barrier was that the program did not have refined assessment tools already developed, so one task was to develop these in the process of implementation. Assessments of student achievement consisted of retention tests, application tests, and standardized tests.

Student perceptions about good thinking behaviors were assessed by surveying students prior to any exposure to Dimensions and then surveying them afterward. Achievement was assessed by comparing students in the same grade level who had teachers in the Dimensions program to students who did not have Dimensions teachers. Two teachers who exhibited a high level of implementation relative to the ideal (see Figure 1) were videotaped. Two master teachers in another school that had a student population similar to that at Willow Creek were also videotaped. Student/teacher interactions were analyzed by an independent evaluator to determine if there were differences in student thinking in the Dimensions classrooms compared to classrooms where the model was not used.

One difficulty was the level of implementation. The SOC results and classroom observations indicated the teachers with the highest levels of implementation. Student achievement data were collected in classrooms where a high level of implementation had taken place for a longer period of time. This tended to put the intermediate teachers who had participated longer in the project at an advantage.

Stage I (September 1990-January 1991) Practicum Outcomes and Processes Used in Achieving Them

In Stage I, from September 1990 through February 1991, teachers who participated in study teams, experienced modeling in their classrooms, and who received other needed support such as budget accommodations began to change their teaching behaviors relative to the model. Two teachers experienced difficulty in changing.

Classroom observations showed that other than those where a unit was developed with a day-to-day lesson plan that she could follow, one new teacher was not using any of the strategies. The teacher who dropped out in January from study team continued to use habits of mind in structuring self-evaluations and in learning logs for students, but did not continue to reinforce students positively even when students clearly demonstrated them. The remainder of the intermediate team consistently positively reinforced habits of mind (Dimension 5) and chose to use other strategies when they were useful in daily lessons. Tarleton (1991) reported additional details related to Stage I.

Observations during planned units revealed a high level of use of the model as a whole and approached the ideal of equal attention over time to all five dimensions (see Figure 1). This held true in the observations of the primary teachers.

Though teams did not always meet twice monthly, they were able to meet as often as they needed to accomplish their goals. In fact, they asked to continue this practice for the next school year (1991-1992). By the end of Stage II, this study team structure was institutionalized.

The effort to eliminate barriers to change and influence teaching behaviors related to the model (see Figure 1) continued throughout Stage II. Six months was sufficient time to initiate change, but not sufficient time for teachers to approximate the ideal.

Teachers participating in the project were given a SOC questionnaire at the end of six months of implementation; the SOC was given again to those who were still actively engaged in implementation at the end of June 1992. A comparison of the questionnaire results and teacher comments showed that a greater level of comfort with the model was indicated at the end of June 1992.

Findings Related to Teacher Change

The results of this questionnaire given in March 1991 are represented in Tables 1, 2, and 3. The results were analyzed using four criteria. These included (a) looking at the scores with a holistic perspective, (b) looking at high and low stage scores, (c) looking at individual item responses, and (d) looking at total scores. Data were compared to comments and impressions created either in study teams, informal conversations, or pre- and postobservation conferences.

In all but one case (intermediate teacher 5), the objective data correlated positively with the informal subjective data. Compared with classroom observations, generally the higher a teacher was in the Stages of Concern (SOC) the more implementation of the model appeared in the classroom when the observation was not of a lesson from a preplanned unit.

Table 1 shows the results for Intermediate (I) teachers, or teachers of grades 4 and 5. These teachers, with the exceptions of teacher 6 (I) and 7 (I), had participated in the project during a formative period (1989-1990) prior to implementation.

Table 2 shows results for Primary (P) teachers, or teachers of grades 1 and 2. These teachers had not participated in the project during the formative period.

Table 1

Listing of Individual Stages of Concern in 1991: Percentile Scores for Dimensions Intermediate (I) Teachers (N=7)

Stages of Concern Percentile Scores

Subject Number	0	1	2	3	0-3 Mean Score	4	5	6	4-6 Mean Score
1(I)	37	63	35	83	54.5	54	72	30	52
2(I)	37	95	97	94	80.75	90	95	57	80.67
3(I)	29	37	12	52	32.5	7	93	38	46
4(I)	77	75	80	83	78.75	48	25	34	35.67
5(I)	46	93	94	69	75.5	96	84	69	83
6(I)	77	80	80	83	80	48	25	34	35.67
7(I)	81	51	28	73	58.25	59	68	98	75
Mean of Column	55	71	61	77	65.75	57	66	51	58.29

Stage 0 = awareness
Stage 1 = information
Stage 2 = personal
Stage 3 = management
Stage 4 = consequence
Stage 5 = collaboration
Stage 6 = refocusing

I = Intermediate teacher grade 4 or 5

They had become interested in the project as a result of conversations with intermediate teachers and decided to form a primary study team to keep the group small and to directly address primary developmental issues related to the model.

Table 2

Listing of Individual Stages of Concern in 1991: Percentile Scores for Dimensions Primary (P) Teachers (N=5)

Subject Number	0	1	2	3	0-3 Mean Score	4	5	6	4-6 Mean Score
1(P)	37	66	65	34	50.5	66	76	73	71.67
2(P)	53	66	85	30	58.5	76	52	47	58.33
3(P)	66	90	92	77	81.25	66	40	60	55.33
4(P)	53	23	31	56	40.75	76	48	38	54
5(P)	60	93	96	39	72	43	80	73	65.33
Means of Column	54	68	74	47	60.75	65	59	58	60.67

Stage 0 = awareness
Stage 1 = information
Stage 2 = personal
Stage 3 = management
Stage 4 = consequence
Stage 5 = collaboration
Stage 6 = refocusing

P = Primary teachers grades 1 or 2

Table 3 summarizes the distribution of Stages of Concern (SOC) between the two groups. It also summarizes the distribution for the combination of teachers in both study teams. Discussion of each table provides the key points from the data.

As shown in Table 1, teacher 1 (I) is extremely analytical. A score of 83 indicating high level of concern related to time, management, and logistics would not be uncommon. Most of her general concerns not related to the innovation are expressed in this area. She was one of the teachers videotaped, and this caused some discomfort with other team members. She also attended the consortium meetings. Her high collaboration score matches nicely with her concerns about working with others.

In February, Teacher 2 (I) had major concerns about not doing as well at implementation as Teacher 1 (I). She had invested as much time and energy as Teacher 1 (I) and received no overt "perks," such as participation in the consortium. She was concerned that the staff-development person did not ask her to participate in the videotaping. Even though classroom observations revealed a high level of implementation of the model, and postobservation feedback was positive, these other considerations were giving her the message that she still was not doing a very good job.

She attended the April consortium meeting, and subsequently all members of all Dimensions study teams were invited to attend the last consortium meeting in Boulder in July 1991. The level of Personal concern was greater than the level of Informational concern. According to the questionnaire manual, this could have put teacher 2 (I) in jeopardy of dropping the innovation altogether. From conversations after her return from the April consortium, the author predicted a drop in her stage 2 level of concern and possibly others as well. Her June 1992 scores substantiated this prediction.

Teacher 3 (I) has a high level of implementation. People who have low scores overall on all or most stages tend not to share opinions, and teacher 3 (I) is no exception.

Teacher 4 (I) dropped the innovation due to conflicts with management concerns. She still has a need for information, however, and she consistently asked for demonstration lessons in her classes even after she dropped study team.

Teacher 5 (I) was an enigma. Observations revealed a high level of implementation, yet her level of personal concern is high.

Teacher 6 (I) was a nonuser. Observations substantiated this.

Teacher 7 (I) would be characterized by Joyce et al. (1989) as a "five-percenter," one of the few who can understand a complex model without the usual follow-up coaching needed by the other 95%. She took a three-day workshop on Dimensions in 1990 before she came to Willow Creek. Though she does not implement the model in her classroom exactly the way the manual intends, she uses what she considers important from the model and is no longer concerned about the innovation at all. She was already planning what new things she intended to try for the 1991-1992 year.

Members of the primary (P) group had less overall exposure to the model than the intermediate (I) group. As shown in Table 2, teacher 1 (P) had a higher level of implementation than the rest of the group, and this individual's scores in stages 0-3 tended to lower the group mean for stages 0-3 about 3 percentage points. Teachers 3 (P) and 5 (P) were in jeopardy of giving up on the innovation. In comparing the stages 0-3 scores to the 4-6 scores, similar scores in both or a much higher score in stages 0-3 indicate early stages of implementation in an innovation. Classroom observations substantiated that this was true for all members of the primary group with the exception of teacher 1 (P).

The combination of the scores, as shown in Table 3, indicates that both groups were still at early stages of implementation and required continued support, modeling, and collaborative planning. Informational concerns provided the highest mean scores. This would indicate that most of the teachers still did not know the model and the strategies well enough to begin using them with students. The model would have to be implemented with those few teachers with high levels of understanding and arrange to have those teachers help in their study team interactions with other members.

Table 3

Summary of Intermediate (I) and Primary (P) Combined in 1991 Stages of Concern Scores (N=12) and Mean Scores for Stage 0-3 and 4-6

	0	1	2	3	0-3 Mean Score	4	5	6	4-6 Mean Score
Means of Each Stage or Stages	54.5	70	68	62	63.25	61	63	55	59.29

Stage 0 = awareness
Stage 1 = information
Stage 2 = personal
Stage 3 = management
Stage 4 = consequence
Stage 5 = collaboration
Stage 6 = refocusing

I = Intermediate teachers grades 4 or 5
P = Primary teachers grades 1 or 2

Stages of Concern reflected in Table 4 generally matched the teachers' level of implementation at the end of February 1991. These were verified by classroom observations. Both groups would have scored higher if this survey had only specified levels of concern related to Dimensions 2 and 5. Habits of mind and strategies related to students' acquisition and integration of knowledge were relatively easier to understand and implement. Comments by study team members verified this. Classroom observation revealed more consistent use of these strategies than of other strategies by study team members in primary and intermediate grades.

Table 4

Frequency of Highest Stages of Concerns in 1991 for Individuals Displayed in Tables 1 and 2

	Highest Stage of Concern						
	0	1	2	3	4	5	6
Number of (I) Individuals	0	0	1	3	1	1	1
Number of (P) Individuals	0	0	3	0	1	1	0
Totals for (I & P)	0	0	4	3	2	2	1

Stage 0 = awareness
Stage 1 = information
Stage 2 = personal
Stage 3 = management
Stage 4 = consequence
Stage 5 = collaboration
Stage 6 = refocusing

I = Intermediate teacher grade 4 or 5
P = Primary teacher grade 1 or 2

After lesson demonstrations by the author and the staff-development person from September through February of 1990-1991, study team members did not express less need for modeling. The original implementation proposal was written for the intermediate team. Because they received no demonstrations from the staff-development person until she returned from leave, it makes sense that they would continue to request them.

Fullan (1982) emphasized the importance of the factor of complexity in implementing an innovation. The theoretical background of this model is foreign to most teachers. The manual that assists in the translation of theory to practice was written in technical language and needed modification. This was done in the summer of 1991. Graphic organizers and other visual representations of the material would have facilitated understanding of the information. The manual is generic and not grade-level specific. As a result, the practical translation is best done through modeling and study team demonstration and dialogue. Particularly, Dimensions 4 and 5 thinking processes need to be simplified in order to be of use to teachers at the primary level. This made the work of the primary study team go slower because the strategies needed to be learned and then modified.

Three of the original primary teachers and three of the original intermediate teachers given the SOC survey in 1991 were given the same survey in June 1992. Results of the second survey are included with 1991 results in Table 5. The Stage I support was not sufficient for teachers to reach automatic levels of implementation in the model. Therefore, teacher support was necessary throughout Stage II. Differences in levels of concern are evident when the 1991 and 1992 results are compared.

In every case reported in Table 5 the highest level of concern was stage 5, collaboration. Scores in stages 0-3 declined from pre to post. This supports the comments of the group now concentrating its efforts on assisting the other

Table 5

Comparison of 1991 Stages of Concern Scores and 1992 SOC Scores

Subject Number	Year	0	1	2	3	0-3 Mean Score	4	5	6	4-6 Mean Score
1(I)	('91)	37	63	35	83	54.5	54	72	30	52
	('92)	60	27	28	27	35.5	71	98	73	80.37
2(I)	('91)	37	95	97	94	80.75	90	95	57	80.67
	('92)	10	27	28	69	33.5	76	97	69	80.67
5(I)	('91)	46	93	94	69	75.5	96	84	69	83
	('92)	29	27	25	27	27	76	97	77	83.33
1(P)	('91)	77	80	80	83	50.5	48	25	34	71.67
	('92)	23	37	31	39	32.5	71	88	77	78.67
2(P)	('91)	53	66	85	30	58.5	76	52	47	58.33
	('92)	37	34	35	27	33.25	66	91	73	76.67
5(P)	('91)	60	93	96	39	72	43	80	73	65.33
	('92)	5	27	35	39	26.5	66	80	69	71.67
Mean of	('91)	52	82	81	66	70.25	68	68	52	62.67
Columns	('92)	27	30	30	38	31.25	82	92	73	82.33

Stage 0 = awareness
Stage 1 = information
Stage 2 = personal
Stage 3 = management
Stage 4 = consequence
Stage 5 = collaboration
Stage 6 = refocusing

I = Intermediate teacher grade 4
P = Primary teacher grade 1

members of the staff in implementing habits of mind throughout the school. Of the original group who took the 1991 questionnaire, teacher 6 (I) did not implement any of the Dimensions model. Teacher 4 (I) used habits of mind as a result of including it on the report card at that grade level. Teacher 3 (P) used habits of mind and strategies from Dimension 2 on a consistent basis. Teachers 3 (I), 7 (I), and 4 (P) have taken jobs out of the district. These teachers did not retake the questionnaire. The complexity of the model is a constraining factor because the long-term effects for students at Willow Creek will not be evident when teachers obtain jobs at other locations. The training of new teachers then takes another two years before differences occur.

The historical description in Chapter 5 outlines the number of study team meetings throughout the period of Stages I and II. Teacher observations made during the 1990-1991 and 1991-1992 school years were graphed according to time allotments in each dimension (see Appendix M) as they had been done in the preimplementation period (see Figure 1). Some were formal observations with preconferences and postconferences. Some were informal observations where there were no pre- and postconferences.

In the preimplementation data (see Figure 1), note that teacher B represents the general picture for all of the teachers who participated in the project. Teacher A did not participate. Comparison of teacher B (see Figure 1) with the individual summaries of observations (see Appendix M) shows increased use of Dimensions 3, 4, and 5. Though the time allotment does not indicate, actual observations indicate an increase in the use of strategies specific to the program in Dimension 2. Some of these include memory techniques such as mnemonics and item linking, strategies to assist in the construction of meaning such as KWL, brainstorming, and reciprocal teaching, and strategies to assist in the organization of information such as graphic organizers, webs, patterning, and others.

Stage II (February, 1991-June, 1992) Practicum Outcomes and Processes Used to Achieve Them

Terminal Objectives

1. After the consistent use of Dimension 5 by participating teachers, students in their classrooms will show growth in identifying and demonstrating habits of mind, as evinced in sample surveys and classrooms observations.

Because the intermediate study team demonstrated a higher level of implementation of the model than the primary team, all student data were gathered from one or more members of this group. Surveys were done of students from the fourth grade team because they had been interviewed as third graders when they had no learning experience with Dimension 5. Students in fifth grade had been exposed to Dimension 5 in fourth grade. Results showed measurable differences in perceptions of thinking behaviors and the ability of students to give personal examples of thinking behaviors.

2. After consistent use of unit planning and Dimensions 2 and 5 in their classrooms, students will show more specific long-term retention of information taught, as evinced by posttests.

Though all tests were not conclusive, most results indicate that use of the model will improve student achievement. Results are reported in the assessment findings.

Process Objectives

1. After support and information gained in study teams from September 1990 through February 1992, participating teachers will demonstrate an automatic level of learning of strategies from Dimensions 5 and 2, as evinced by classroom

observations spread throughout the implementation period beginning in February of 1991.

One fourth grade member of the intermediate team did not reach an implementation level. A fifth grade member reached an automatic level in Dimension 5 only. The other five intermediate team members demonstrated an automatic level of implementation. However, one fifth grade member received a staff-development position in the district after the 1990-1991 school year. Another fifth grade member received a promotion mid-year of the 1991-1992 school year. Both of these fifth grade teachers had demonstrated high levels of implementation. This made data collection of fifth grade students impossible in the 1991-1992 school year.

Members of the primary team demonstrated consistent use of most self-regulated behaviors, some critical thinking behaviors, and fewer creative behaviors from Dimension 5 in observations. Favorite strategies from Dimension 2 were used such as KWL, brainstorming, graphic organizers, and some memory techniques. The full Dimension model was used only in units planned with the unit planning guide and in collaboration with other team members.

Results from the SOC questionnaire support primary and intermediate teachers' perceptions of growth related to the model (see Table 5). Of the original seven intermediate teachers and five primary teachers, three moved from the school, one dropped the innovation completely, two achieved a moderate level of implementation, and the remaining six are reflected in Table 5. Personal comments in study teams and classroom observations throughout the second year of implementation in 1991 and 1992 match the perceptions recorded in Table 5.

2. After unit planning in study teams from April 1991 through June 1992, participating teachers will demonstrate the ability to plan units focused in specific content areas independently and include the use of all five dimensions in those unit plans.

Study team members indicated a comfort with using the new unit planning sheets developed in summer, 1991. If members worked together to plan a unit, they implemented according to the plan. In this way, members who were not at automatic levels with all five dimensions could still implement a unit plan that incorporated strategies from all five dimensions. This was well-suited to such subjects as social studies and science which tend to be planned as units by grade-level teams. Classroom observations matched teacher reports. Later data will indicate the achievement results in social studies and science units.

For units that were not cooperatively planned by teams of teachers, implementation of the model in individual classrooms tended to match the level of mastery of the model by the individual teacher. Favorite strategies were used and few attempts were made to use less familiar strategies.

Standardized Tests Findings

Social Studies Criterion-Referenced Test

In May of the 1989-1990 school year in the early stages of implementation, the three fifth grade teachers planned a unit on the federal government using strategies from all five dimensions of the model. None of these teachers was at a high level of implementation at the time, but they worked together as a collaborative team to learn the strategies that they incorporated into the unit and planned the unit together. They were provided support from the principal and the staff-development trainer to develop the unit. The current unit planning guide had not been developed at that time. None of the other units in social studies had been taught using the Dimensions strategies.

The students were given the district criterion-referenced test for social studies. The subtests in this test are related to the district objectives for fifth grade social studies. This measure had been developed by the district office of evaluation. The identical test had been given to students in the same teachers' classes in the previous school year. Table 6 delineates the results of the test for

Table 6

Comparison of Subtest Scores on Social Studies Criterion-Referenced Test for 1989 and 1990

Subtest Objective Name	1989 Group I		1990 Group II		Group Diff
FedGovBrches:Str/Func/Ck&Bal	40.24		56.01		+15.77
FedGovBrches:Respon&Limitat	62.50		70.89		+ 8.36
x 2 Tests		51.37		63.45	+12.08
Maps:Locate-Land/Topgraphy	84.55		83.12		- 1.43
U.S.History:New Government	60.61		61.39		+ .78
Maps:SymbolInterpretation	86.41		82.28		- 4.13
Maps:Measurement	69.51		67.09		- 2.42
U.S.History:Colonies	55.47		54.11		- 1.36
U.S.History:Pre-European	57.32		54.01		- 3.31
U.S.GeographicalRegions	64.33		59.18		- 5.15
Maps/US StatesRiversLakes	78.41		71.77		- 6.64
U.S.History:Discovery/Explor	65.55		60.13		- 5.42
Maps/Grid System	70.73		64.77		- 5.96
MapInterpretation	62.93		56.96		- 5.97
U.S.Features/Water&Mtns	70.73		62.97		- 7.76
Maps:LocateContinents&Oceans	76.83		66.58		-10.25
U.S.History:Revolutionary War	75.26		63.47		-11.79
x 14 Tests		79.45		69.83	- 9.62

both groups of students. Group I students did not receive instruction in their federal government unit which was planned with the Dimensions strategies. Group II did. In the composite of all subtests except the federal government subtests, the Group II mean was -9.62 below the Group I mean from 1989 to 1990. Group II was below Group I on 13 of 14 subtests other than the 2 taught using the Dimensions model. For the federal government subtests (using Dimensions) the Group II means were above the Group I means on 2 of 2 subtests, and the composite mean for the 2 tests showed Group II ahead of Group I by +12.08. On the composite mean for the other 14 subtests, Group II was behind Group I by -9.62. Although no statistical test of significance was computed, evidence suggests that Group II profited from the Dimensions instruction in the 2 federal government subtest results.

When the two groups were compared on subtests for their fifth grade year on the Iowa Test of Basic Skills, Group II tended to score close to or below the level of achievement of Group I. The composite scores for Group I and Group II were 78 and 76, respectively (see Appendixes N and O). In comparing each subtest of the social studies criterion-referenced test between the two groups, the conclusion could be drawn that the first group should score about the same or better than the second group. There is a 9.62 difference in the means on 14 of the subtests with the exception of the 2 federal government subtests. In the case of the federal government subtests there is a 12.08 difference in favor of Group II. When teachers reviewed this information, they were encouraged by the results. This, along with their personal observations of student achievement in the federal government unit, caused them to be enthusiastic about working on more

Dimensions units in 1990-1991. Unfortunately, the district revised the social studies curriculum that next year, and the criterion-referenced test was not given in 1990-1991. To date, a new test has not been developed.

Math Concepts Subtest of the ITBS

A group of fourth graders who had also been surveyed relative to growth in "habits of mind" were given the math concepts subtest of the ITBS. Results of this subtest are compared with the survey results in Table 13.

Retention Tests Findings

Two tests were given to students from Willow Creek and to students from a neighboring school with a similar population. This neighboring school is in the Cherry Creek District, and its students score as well or better than students at Willow Creek on the ITBS. The populations are similar in socioeconomic and ethnic factors. Conditions for administration of the tests were the same. Students from both schools were heterogeneously grouped. Both groups were instructed using district curriculum objectives. The test was administered in April of 1991.

Colonies Test

Two control groups from the fifth grade at a neighboring school were administered the retention test for the American colonization unit. One experimental group from a Willow Creek Dimensions class was given the same test. The teacher of the Willow Creek group had planned her colonization unit using the Dimensions planning model. Control group 1 consisted of 24 students. Control group 2 had 27 students. The experimental group had 21 students.

A copy of test questions and the grading rubric are included in Appendix P. The maximum number of points was 12. Two people graded the questions using a blind grading system ($r=.73$; $n=72$).

The analysis of the data was done in a three-step process. Step 1 was the analysis of variance (ANOVA). ANOVA results are in Table 7 and show that there are statistically significant differences in the comparison at the $p \leq .01$ level.

Step 1

Table 7

Analysis of Variance—Colonies Retention Test

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	57.91	28.96	5.49	.006
Within Groups	69	363.74	5.27		
Total	71	421.65			

Group	Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	95 Pct Conf Int for Mean
Ctrl 1	24	4.25	2.05	.42	2.0	9.0	3.39 to 5.11
Ctrl 2	27	5.33	2.35	.45	2.0	11.0	4.40 to 6.26
Expl 3	21	6.52	2.82	.54	2.0	10.0	5.39 to 7.65
Total	72	5.32	2.44	.29	2.0	11.0	4.75 to 5.89

F is significant $\leq .01$ level.

Ctrl = Control Group

Expl = Experimental Group

Step 2

In step 2 the Tukey-HSD Procedure was applied to determine whether there existed significant variations between pairs. Group 3 was significantly different from Group 1 at $p \leq .05$ (see Table 8).

Table 8

Tukey-HSD Procedure—Colonies Retention Test

Mean	Group	Grp 1	Grp 2	Grp 3
4.25	Cntrl 1			
5.3333	Cntrl 2			
6.5238	Expl 3		*	

Cntrl = Control Group Expl = Experimental Group

(*) denotes pairs of groups significantly different at the $p \leq .05$ level.

Step 3

In step 3 a planned comparison method was used to determine if the combined scores of groups 1 and 2 varied significantly from the group 3 scores. Group 3 scores were significantly higher than the combined group 1 and 2 scores at the .05 level.

Solar System Test

For the solar system test two control groups were from the fourth grade classes at the same neighboring school and two experimental groups were from Willow

Creek classes who had been taught using the Dimensions program as a plan for instruction. The conditions were the same as for the colonies test. Again the purpose of the assessment was to test recall of information delineated by the district science curriculum that was identical for both schools.

Step 1

Table 9

Analysis of Variance—Solar System Retention Test

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	3	28.18	9.39	3.09	.03
Within Groups	76	231.21	3.04		
Total	79	259.39			

Group	Count	Mean	Standard Deviation	Standard Error	Minimum	Maximum	95 Pct Conf Int for Mean
Ctrl 1	22	6.23	1.80	.38	2.0	8.0	5.43 to 7.02
Ctrl 2	22	5.32	1.81	.39	2.0	8.0	4.52 to 6.12
Expl 3	19	6.68	1.73	.40	3.0	9.0	5.85 to 7.52
Expl 4	17	6.82	1.59	.39	3.0	9.0	6.01 to 7.64
Total	80	6.21	1.81	.20	2.0	9.0	5.81 to 6.62

Ctrl = Control Group Expl = Experimental Group

A copy of the test questions and the grading rubric are included in Appendix Q. Two people used a blind grading system to evaluate the results of the tests. Three steps were used in analysis of the test results. These included ANOVA, the Tukey-HSD procedure, and the planned comparison analysis. The results are included in Tables 9 and 10. The maximum points were 10 (r=.771 N=80). The ANOVA showed that differences were statistically significant ($p \leq .05$).

Step 2

In step 2, the Tukey-HSD procedure showed that group 4 (experimental) was significantly ($p \leq .05$) higher than group 2 (control) (see Table 10).

Table 10

Tukey-HSD Procedure—Solar System Retention Test

Mean	Group	Grp 2	Grp 1	Grp 3	Grp 4
5.32	Cntrl 2				
6.23	Cntrl 1				
6.68	Exprl 3				
6.82	Exprl 4	*			

Cntrl = Control Group Exprl = Experimental Group

(*) denotes pairs of groups significant at the .05 level

Step 3

In step 3, a planned comparison analysis was done. The combined means of control groups 1 and 2 were compared with the combined means of experimental groups 3 and 4. They were not significant at the $p \leq .05$ level, but were at the $p \leq .10$ level.

Application Findings

The application test was designed to assess not only retention of information, but also the application of the information to a new situation. Students for the control groups were selected from a different neighboring school in Cherry Creek District. Students in the control group had similar ITBS test scores and matched socioeconomic and ethnic factors with the experimental group from the Willow Creek classroom where the unit had been planned using the Dimensions model. This application test related to district objectives in science, specifically, to the human respiratory system.

A copy of the test questions and the grading rubric are included in Appendix R. Two people graded the test using a blind grading system. Using a T test, scores for students in the experimental and control groups were compared for individual questions. Table 11 shows the results. Questions one and two were significant at the $p \leq .05$ level. No significance was found for question three. For question four, the question that required the greatest ability to apply knowledge to a new situation, it was significant at the $p \leq .001$ level.

Student Thinking Findings

Two kinds of assessments were used to collect data related to student thinking. The first was a survey of students who had no introduction to

Table 11

Summary of Results for Application Test—Respiratory System

	X Exp	N	X Cntrl	N	T-Value	Sig. Level
Q#1	8.00	17	6.48	23	1.87	.05
Q#2	6.31	16	4.93	24	1.88	.05
Q#3	6.24	17	5.33	24	1.48	NS
Q#4	6.59	17	4.13	23	3.54	.001

Q = Question
Exp = Experimental Group
Cntrl = Control Group
Sig = Significance

Dimension 5 habits of mind in their third-grade year. They were then surveyed in their fourth-grade year after habits of mind had been introduced to approximately 75% of them. The results are reported in the habits of mind findings.

The second assessment was done by outside evaluators, Charles Fisher and Alice Horton from the University of Northern Colorado. Four sessions of video tapes from each of four teachers were analyzed. Two teachers were Dimensions teachers who demonstrated a high level of implementation of the model and two were master teachers from a neighboring school in the district. The results of these data are reported in the findings in instructional influences on student thinking.

Habits of Mind

In the school year 1990-1991, a classroom of students in the third grade was surveyed concerning their perceptions about thinking. At that time, they were grouped heterogeneously by levels of achievement in reading. In the school year 1991-1992, the same students were distributed among the four fourth-grade teachers (1 (I), 2 (I), 5 (I), 6 (I)). Teacher 6 (I) had dropped the implementation of the Dimensions innovation except when she taught a social studies or science unit planned using the Dimensions planning guide in collaboration with team members.

Students were asked identical questions both years. They were encouraged to elaborate on their responses by using such prompts as "Could you tell me more about that?" or "Could you give me another example?" Wait time was provided so that the student could think before responding.

The results from the first year were not graded with a blind system because the grader was aware that they had come from the same class. A blind system was used grading the results of the second year. The students were asked the following questions.

1. Do you think you are a good thinker? If so, give me example of things you do that make you think that you are.

2. If not, do you know a person who is a good thinker? Give me examples of things that person does that make you think they are.

3. If the student responded with a habit of mind, he/she was asked to tell what that meant and give examples of when he/she had exhibited that particular behavior.

These results were compared to pre- and posttests done on the math concepts subtest of the Iowa Test of Basic Skills. The pretests were given in October of 1991. The posttests were given in May of 1992 to the same group of students who had been administered the student thinking questionnaire. The tests are normed for the time of year in which they are administered. Therefore, average growth should reveal similar pre- and postsubtest scores for each student.

Students who had been given the habits of mind questionnaire were also given the math concepts subtest of the ITBS. The results are included on Table 12 and are compared with the results of the "habits of mind" questionnaires. Because the ITBS is not a test that requires higher order thinking (Costa & Marzano, 1988), the prediction would be that a model that gave equal attention to thinking and learning strategies and content knowledge would not necessarily improve ITBS test scores. The subtest was given because of national, state, and local factors that still place a major emphasis on nationally normed standardized tests.

In reviewing the scoring rubric and looking at the examples on Table 13, even a score of 2 would be an acceptable increase in student perceptions about good thinking. Having the students supply personal examples was an attempt to determine if they understood the behavior and chose to behave in that manner at least enough to give an example.

The premise of explicitly teaching these behaviors is not so that students will behave in these ways all of the time; that is an ideal world in which even the best of the intelligentsia do not function. The goal is to reinforce these behaviors positively in the classroom so that students can (a) understand the behaviors, (b) choose to behave in these ways when the choice is beneficial to them, and (c) understand the link between habitually behaving in these ways and their physical, social, and academic success. The growth is evident. It would be interesting to

Table 12

Math Concepts Subtest of the Iowa Test of Basic Skills Compared with Student Perceptions of Thinking Questionnaire

	Student Perceptions of Thinking			Math Concepts	Math Concepts	
Student #	Scores '90	Scores '91	X Diff	10/91	5/92	Diff
(D) Teacher #1 (I)						
11	1	3		17	99	+82
12	1	5		94	95	+1
14	1	4		None	54	None
19	2	3		88	95	+7
20	1	5		70	54	-16
ITBS Mean Diff X	1.2	4.0	2.8	67.25	85.75	+18.5
(D) Teacher #2 (I)						
3	1	1		33	80	+47
10	1	3		22	66	+44
16	1	4		82	60	-22
18	1	5		88	72	-16
ITBS Mean Diff X	1.0	3.25	+2.25	56.25	69.5	+13.25
(D) Teacher #5 (I)						
1	1	3		33	44	+11
8	1	5		91	88	-3
9	1	5		88	72	-16
13	2	4		77	95	+18
17	1	4		77	66	-11
ITBS Mean Diff X	1.2	4.2	3.0	73.2	73	-2.0
(R) Teacher #6 (I)						
2	1	1		99	95	-4
6	1	1		77	None	None
7	1	1		None	66	None
15	1	1		64	27	-37
ITBS Mean Diff X	1	1	0	80	63	-20.5

D = Dimensions Teacher R = Regular Teacher

Table 13

Scoring Rubric for Habits of Mind Surveys and Examples

1 Most or all responses do not relate to habits of mind or other commonly accepted higher order thinking behaviors.

2 Most responses are related to habits of mind or other commonly accepted higher order thinking behaviors (with examples of the behavior given).

3 Most responses are related to habits of mind (with examples of the behavior given) but the language of habits of mind is used in only one example.

4 Most responses are related to habits of mind (with examples of the behavior given) and the language of habits of mind is present in those responses.

5 All responses are related to habits of mind and the language of habits of mind (with examples of the behavior given).

Illustrative Examples of Each of the Rubric Scores

1 Good thinkers know a lot of things; listen to the teacher; know how to spell things right; answer fast; are good in math; get things right; get 100%

2 Good thinkers use their imaginations well like making something new from a straw and paper clips; come up with good ideas like in math I have several ways to figure out the answer for a problem

3 Good thinkers use critical thinking; they try to make sure they understand something and if they don't they ask for more explanation; not the answer, they put in a lot of effort

4 Good thinkers plan ahead, like I try to do my homework before I go to a friend's house to play; seek accuracy; don't just rush through your work so you can get it done; go back and check; set goals

5 Good thinkers are accurate and seek accuracy; like in my writing I go back and check my spelling; when I did paired reading with the younger kids, I tried to help them and not make fun of mistakes; are aware of their own thinking; I don't let other people tell me what to do, I decide; push their limits, when I'm doing some hard problem in homework, I keep trying different things

conduct a longitudinal study of students who had been exposed to these Dimension 5 behaviors over the period of time of their elementary school years to see if their examples were more numerous and elaborate and whether they linked these behaviors to their personal successes.

Table 12 also indicates that if students are not explicitly taught about thinking behaviors, their perceptions change very little from one year to the next. Scores of students in the classroom of teacher 6 (I) illustrate this point.

Although the students in the Dimension classrooms experienced an average of 10.42 over their expected growth, it is difficult to draw an inference using the ITBS data. This is due in part to the marked fluctuations (+ and -) of some of the scores and the fact that only two of the students from the classroom of the teacher who did not implement Dimensions were present for both the pre- and posttests.

Teacher Behaviors Which Affect Student Thinking: Videotape Analysis

Dr. Charles Fisher and Alice Horton, of the University of Northern Colorado, analyzed four videotapes from each of four teachers. Two were Dimensions teachers from Willow Creek who demonstrated a high level of implementation of the model and two were master teachers from a neighboring school with a similar student population in terms of achievement, socioeconomic status, and ethnic mix.

Four videotapes were made in each of the two regular (R) classrooms and in each of the two Dimensions (D) classrooms. Three of the teachers' lessons were in science and the fourth was in Colorado history. The Colorado history lessons were in one of the Dimensions (D) classrooms. Videotaping occurred during the second week in March 1991 in the (R) school and the third week of March 1991 in the (D) school. The Fisher and Horton document titled Some Instructional Influences on Student Thinking in Classrooms, June 15, 1992, is presently in draft form (see Appendix S).

The problem was stated in several questions. Does extensive training in Dimensions result in higher levels of thinking on the part of students? Do activities structured according to the Dimensions model result in greater learning of thinking skills and content? What is the difference in the experience for students when the teacher has been trained in the Dimensions model versus the experience for students in a similar class where the teacher has not been trained?

Since thinking is not easily observed, the kinds of thinking in which students were engaged was indirectly determined by tasks in which students were engaged and the student/teacher talk. The kinds of tasks were divided into eight characteristics that included activity, purpose, duration, function, format, product type, product specification, and complexity.

Kinds of Tasks

Function was divided into three subcategories. If the work was primarily done before the student was engaged in the task, it was called prework. Work in which the student was engaged was called student work activities. If students were engaged in reflecting on or refining work on an activity, it was called a completion activity.

Activity format referred to teacher-led talk, student-led talk, or a combination. Activity product referred to who was producing the product. Examples might include (a) an individual student, (b) a group of students, or (c) no product.

Product specification was graded on a scale of 1-5. This scale determined to what extent the students determined the product.

The complexity of the task was classified according to Bloom's taxonomy (Bloom, Englehart, Furst, Hill, and Krathwohl, 1956). The six Bloom's classifications were then merged into three categories, high, medium, and low.

Teacher/Student Talk

Typed transcripts were used to determine what the teacher said and what the student said. Audiotapes were placed in classrooms to supplement the scripts from the videotapes. The number of turns taken by the teacher and the students were counted. A student turn was indicated by a response of more than a word or a short phrase. It was particularly noted if a student (a) elaborated on a concept, (b) explained a relationship, (c) extended the meaning of the information, or (d) constructed meaning in a response.

Teacher talk was analyzed for references to metacognitive thinking, learning strategies, or the coaching of thinking processes. Note was made of the complexity of the teacher's questions and the length and depth of the response to the questions. Examples of the dialogue appear in the document (see Appendix S, pages 172-176, 189-191, 193, 197-201, and 206-212).

Analysis of Task Structures

Although each teacher's lessons varied in terms of activity structures, some patterns emerged which distinguished the pair of Dimensions teachers from those of the other two teachers. The Dimensions teachers' lessons were somewhat shorter (41-45 minutes versus 52-53 minutes). Their activities changed more often—on the average about every three minutes versus an average of five minutes for the other pair.

Activity function varied considerably among all four teachers in prework activities. The Dimension teachers spent less time than the other pair in work activities but more time, 29-30 minute average, on completion activities compared to an average of seven to twelve minutes for the other pair. Completion activities often require students to reflect on or express thoughts about their work. This occurred more often in the Dimensions classes.

Activity formats included three categories: (a) discussions where the teacher talked more than students (teacher-talk), (b) discussions where students talked more than teachers (student-talk), and (c) everything else (other). Differences between the pairs were not significant except that the teacher-talk format was considerably less in one of the Dimensions classrooms and the student-talk was considerably less in one of the non-Dimensions classrooms.

Marked differences occurred between the pairs when activities were classified by complexity. In the Dimensions classrooms, students spent one-third of their time in activities rated higher than the knowledge/comprehension levels of Bloom's taxonomy. Time spent by students in the other classes was less than one eighth.

In three of the classes, students spent two-fifths of their time working on concrete products such as writing, pencil and paper exercises, constructing physical objects, and so on. In one of the Dimensions classes the time was one-fifth.

When students worked on concrete products in the Dimensions classes, they almost never worked on products completely specified by the teacher. In the other classes, one teacher exclusively specified the products, and in the class of the other teacher, one- quarter of the instructional time was spent on products specified by the teacher or other source and one-eighth of the time on products where students had a moderate level of influence.

Between the pairs, overall task structures were different. Within the pairs, the Dimensions teachers were more alike than the other two. The Dimensions classes were faster paced, had longer completion activities, were more cognitively complex in terms of activities, and had products over which students had more influence. The conclusion was that more higher level thinking opportunities were provided for students in the Dimensions classes.

Analysis of Talk Structures

Teacher-talk exceeded student-talk in all classes. Student-talk was greatest in one of the Dimensions classes. The other Dimensions teacher also had greater student-talk than in the regular classes though not as much as in the other Dimensions class. More student-to-student discussions took place in the Dimensions classes; also student responses were more often extended. Student summaries and interpretations of work occurred more often in Dimensions classes than in the regular classes. Dimensions teachers more often referred to strategies for learning, metacognition, and self-regulation, and Dimensions classes were characterized as having longer students answers, more high-level questions, and less evaluation of answers, than did the regular classes (see Table 14).

Table 14

Comparison of Variables in Teacher/Student Interactions Analyses [Ranked from Most(1) to Least(4)]

		Talk Structures		Task Structures			
Class	Type	Student Talk	Teacher Talk	Cognitively Complex	Student Influenced	Fast Paced	Completion Activities
Candel	D	1	4	1	1	1	2
Landis	D	2	3	1	1	1	1
Markfield	R	4	1	2	2	2	4
Standford	R	3	2	2	2	2	3

Larger Patterns

Class	Type	Acquiring Information and Studying How to Acquire It	Student Interpretation of Information	Longer Student Responses	Teacher References to Thinking
Candel	D	1	1	1	1
Landis	D	1	1	1	1
Markfield	R	3	2	2	3
Standford	R	2	2	2	2

Talk Structures

Student Talk: S to S & S to T

Teacher Talk: T to S & T to C

D=Dimension
R=Regular
S=Student (Individual)
T=Teacher
C=Whole Class

* If the same number appears in a column for two teachers, there is no observable difference between the two.

Larger Patterns

Fisher and Horton drew some general conclusions about the patter distinctions between the Dimensions teachers and the other pair of teachers. In the Dimensions classes, the purpose of instruction is to have students acquire the subject matter content and to study how to acquire the content. Almost equal time was spent on both purposes. The other pair spent almost all of their time on having students acquire content.

Two Views of Knowledge

In the Dimensions classes, students spent a portion of their time interpreting their own data rather than having the data interpreted for them. Teachers elicited more than one interpretation of the data from a variety of students. Students were allowed opportunity for constructing their own meanings. In the other classes, one interpretation of the data was almost always the case. Conceivably, in this condition, students might conclude that the knowledge has one source.

In Dimensions classes where there was more student-to-student talk than in the other classes, interpretation of knowledge was more evenly distributed among students and teachers. In the other classes where student-talk tended to be between teacher and student, students could more easily interpret that knowledge resided with the teacher.

Dimensions classes spent substantial time on framing problems, posing problems, or identifying what students wanted to know. By comparison, students in these classes might infer the equal importance of problem posing and of problem answering. The other classes spent the majority of their time on solving problems presented to the class. The two views of knowledge that are represented are that knowledge is internal, subjective and dynamic rather than external, objective, and static. Quadrant 1 of Table 15 reflects the good condition for student thinking.

Table 15

Problem Posing and Problem Answering

(1) Good Problem, Good Answer

(2) Poor Problem, Good Answer

(3) Good Problem, Poor Answer

(4) Poor Problem, Poor Answer

	Problem Posing: Good	Problem Posing: Poor
Good	1	2
Poor	3	4

* Problem Posing is probably more important than Problem Answering.

Two Views of Teaching

One pattern that emerged was contrasting views of teaching. Dimensions teachers operated primarily as facilitators and metacognitive coaches. They encouraged students to think aloud by being nonevaluative and asking them to "say more." References were made to finding resources for answering questions. Questions were often answered with questions. They asked more open-ended questions than did the other teachers. Eliciting prior knowledge helped students to construct meaning. In these classes, students were able to negotiate some control over content.

The other teachers operated as sources of knowledge. They corrected students misperceptions, answered student questions with information, and seldom elicited prior knowledge from the students. These teachers acted as content experts, though all four were approximately equal as experts in the content. Student control over the content was minimal.

Two Views of Learning

In the Dimensions classes, students were expected to construct meaning from the information, organize it, present and interpret it, and build on prior knowledge. In the regular classes, students were expected to absorb the information. The differences in time spent in the Dimensions classes interpreting data, reflecting on what was learned, and extending and summarizing the information were significant from time spent in the regular classes. Because teachers in the regular classes were interpreting most of the information for the students, they were also doing most of the higher level cognitive processes for the students.

Coverage of Content

Coverage of content varied between the pairs because of the dual purpose of the Dimensions classes versus the single purpose of the regular classes. In one regular classroom, students actually covered the content twice within the four lessons. Possibly for tests of short-term knowledge and comprehension of content, students will score better from classes where knowledge acquisition is the primary purpose, especially if there is a direct match between the test and the content. It does take time to teach thinking and learning strategies.

Table 16 summarizes the two views represented in the Dimensions classrooms versus the regular classrooms. Because more time is spent in acquisition of the content in the regular classroom versus the Dimensions classrooms where time is also devoted to teaching students how to acquire information, the assumption was made that students from the regular classroom would score better on standard retention tests than students in the Dimensions

Table 16

Summary of Two Views: Regular and Dimensions Classrooms

Views of	Regular Classroom	Dimensions Classroom
Knowledge	One interpretation of data by teacher; knowledge has one source; students solve predetermined problem; knowledge is external, objective, and static	Several interpretations of data by students; knowledge source resides with students and teachers; problem posing and answering are equal; knowledge is internal, subjective, and dynamic
Teaching	Teacher as source of knowledge; teacher answers questions; student control of content minimal	Teacher as facilitator, metacognitive coach; students encouraged to think aloud; teacher non-evaluative; various references sought to find answers; questions are open-ended; prior knowledge is elicited; students negotiate control over content
Learning	Students absorb information; teacher interprets information; teachers do most of higher level cognitive processes for the students	Students construct meaning from information, organize it, present it and interpret it; students reflect on what they learn, extend and summarize information; students are engaged in higher level processes
Coverage of Content	Time is devoted to content acquisition	Time is devoted equally to acquisition of content and learning how to acquire content

classrooms. Data in Tables 7, 8, 9, and 10 do not support this assumption for students in other Dimensions classrooms.

Conclusions

The contrast in views represented in the Fisher and Horton analysis and in Table 16 closely match the principles of the Dimensions model (see Appendix A). The two Dimensions teachers have internalized the model well enough to initiate the paradigm shift in student thinking and learning. If the view of learning is acquiring content, solving predetermined problems, regurgitation of information, and limiting application of knowledge, then the paradigm of the regular classroom is more efficient and suitable. If the view of learning is acquiring and integrating content; problem posing and problem solving; changing knowledge once it is acquired; thinking creatively, critically, and in a self-regulated manner, then the Dimensions paradigm is more suitable.

Table 17 summarizes the positive and negative results of each of the findings. In every case, the Dimensions classrooms showed no significant difference or significantly better results in student achievement than the regular classrooms.

Data was collected in classrooms where teacher behaviors reflected a high level of implementation of the model. Because intermediate teachers had more exposure to Dimensions than the primary teachers, they tended to have higher levels of implementation.

Classroom observations in the primary grades showed that primary students demonstrated habits of mind, learned strategies for acquiring and integrating information, and extended and used knowledge by applying modifications of the strategies in Dimensions 4 and 5, particularly in planned units. First grade

Table 17

Summary of Findings

Findings	Regular	Dimensions
Standardized Tests Findings		
Social Studies Criterion-Referenced Test	-	+
Math Concepts Subtest of ITBS	-	+
Retention Tests Findings		
Colonies Tests	- or NS	+ or NS
Solar System Test	- or NS	+ or NS
Application Test Findings		
Respiratory System Test	- or NS	+ or NS
Student Thinking Findings		
Habits of Mind Questionnaire	-	+
Fisher & Horton Videotape Analysis	-	+

Plus (+) = positive results compared with other group
Minus (-) = negative results compared with other group
NS = no significant difference between the groupsA combination means subsets of the test reflected one result while other subsets reflected another result.

students were observed making decisions about where their families could live in the world based in student-generated criteria. Using complex tasks with all grade levels assisted students in making new cognitive connections (see Figures 2 & 3). The concrete level of the tasks needs to be modified to match the concrete level of the student.

Side Effects

Side effects occurred in the areas of teacher attrition, development of the planning guide, district influences, and school organizational patterns. Data collection was difficult due to the number of teachers who left Willow Creek for jobs elsewhere and the inclusion of new group members. (This is a common problem of research in schools and of testing innovations in schools.) The original intermediate group had "played" with the model in its early stages of development in the 1989-1990 school year. This gave the group an advantage in implementation over the primary group. Of the original seven members of the intermediate group, two left before the completion of the project. These two scored higher in stages 4-6, versus 0-3, on the original 1991 SOC than some of the other members of that group. They had internalized the model more quickly and would have otherwise been good candidates for additional data collection if they had stayed. One member of the primary group also left at the end of the 1990-1991 school year.

Because the teacher's guide, planning guide, and even the language of the model were being modified, implementation was made more difficult. For most teachers, at least two years was needed to understand the theory and strategies incorporated in Dimensions. To date, some of the strategies in Dimensions 4 and 5 are still not clear, and favorites of the teachers like comparison, classification, and problem solving tend to be used.

Given the complexity of the model and the time necessary for implementation, one might easily conclude that the process is too difficult to undergo. A solution to this problem is the use of the planning guide. This guide assists groups in planning content that is generally done in units with specified periods of time. Elementary social studies and science units, as well as literature units, are good examples. When units are planned in this way, the number of strategies necessary to master in each Dimension is limited, and teachers, even those with less knowledge of the model as a whole, experience less difficulty in implementation. This was a gradual discovery made by study team members in both groups. Had they realized this from the beginning, the way that they set about learning the model may have been dramatically different. How much general carryover of strategies there would be to content not usually planned in this way, is a question yet to be answered.

Another unanticipated problem was that the district began to focus on proficiencies and performance assessments in the 1991-1992 school year. Because of this, the study teams tried to align their goals with district goals. Performance assessments would have been a facilitating factor in one more year because they match well with Dimensions 4 and 5. By that time, McREL would have been in a position to provide better support. Teams could have spent one more year strictly concentrating on unit planning and refining their knowledge of Dimensions 4 and 5. As it stood, the timing caused this to be a temporary constraining factor. In combining the two goals, neither was accomplished at a completely satisfactory level. By the end of next year, performance assessments at the district level should be a facilitating factor. Working on performance assessments for the 1991-1992 year has served to reinforce the necessity of long-term complex tasks in student refining and using knowledge.

Because of the Dimensions study teams, this organization for staff development has become a part of the school organization. The School Improvement Committee used a modification of the study team approach and reported in its end-of-year report that this time schedule and data-gathering approach had greatly facilitated its accomplishments for the 1991-1992 year (see Appendix J).

The budgeting for substitutes to allow the group planning is now a permanent part of the school staffing design at a cost of less than .2 of a teacher slot.

Reflections of the Solution Strategy

The data from the June 1992 SOC questionnaire and classroom observations (see Appendix M) indicate that solution strategies to remove barriers to implementation have been successful for most teachers. Positive perceptions on the part of Dimensions teachers have convinced the entire staff to implement habits of mind in all Willow Creek classrooms. One teacher dropped the innovation entirely. Two others are using Dimension 5 and selected strategies from Dimensions 1 through 4 on a limited basis. Bob Marzano remarked that in early stages of development of a project such as this it is not uncommon for an entire school to drop the project.

Concentration on Dimensions 2 and 5 did provide the divisibility Fullan (1982) suggested. Unit planning also accomplished this. Had this issue of performance assessment not emerged as a district mandate when it did, divisibility would have been better maintained. This was particularly true for the primary team who tried to concentrate its efforts in the area of reading. So much of the time focused on assessment in reading that unit planning became secondary.

The Hopkins (1985) "teacher-as-researcher" model had one of the greatest effects not only on the Dimensions teams, but also the rest of the staff and even the School Improvement Committee. Teachers remarked to the principal's supervisor, at the end-of-the year evaluation in 1992, that they appreciated being treated as professionals who could be responsible for solving student achievement and curriculum problems. This was directly related to the study team approach.

Had the data collected at the end of 1991 been analyzed by September of 1991, teachers would have been motivated by the positive effects on student learning. The data were not analyzed until June 1992 in most cases, and this solution had very little to do with the outcome of the project. Results of the habits of mind surveys and the criterion-referenced tests were shared prior to the end of the 1991-1992 school year. Teachers are interested and the results will be shared in September of 1992.

The habits of mind surveys revealed positive growth in students' perceptions about thinking. Performance assessments were piloted, but not refined to the point that they could provide adequate data. Instead, they helped teachers understand the learning paradigm (see Table 15) of facilitating students in generating some of their own content versus seeing the model as a bag of tricks for helping students learn and commit to memory content unilaterally determined by the teacher. Data were gathered using retention tests and application tests following units of study.

Implications of Outcomes and Processes

The teachers who implemented this model in their classrooms and struggled to maintain their tolerance for ambiguity are to be commended. This is not an indictment of those who dropped the innovation. Implementing a piloted, revised, fully developed program is difficult enough. Any kind of change is difficult. To work with a developer; to offer suggestions and modifications; and to tolerate changes in strategies, language, and format takes a dedicated group of professionals. One "perk" was teachers being able to see the effects of their feedback in the changing information. Another faculty wishing to implement this model would not experience the same difficulties that this group did.

Success resulted from the collegiality that developed in study teams. The group set goals for themselves that were achievable from one meeting to the next (Keedy et al., 1989). Teachers were not afraid to make comments such as, "That was a total disaster for me; tell me what you did that made it go well for your kids!" or "I was still trying to remember to reinforce habits of mind and only used the memory strategy once; tell me how it went for you." The group was facilitative, not punitive. They continually made positive comments about having sufficient time to work on refining their teaching skills with one another (Keedy et al., 1989; Achilles & Gaines, 1990).

They tried to use strategies from the model to teach themselves the model. For instance, before they taught their children habits of mind they worked out examples of times when using a particular habit of mind had made a significant difference in their own thinking or times when not doing so had negative results for them personally. Eliciting their own prior knowledge and constructing their own meaning made strategies more understandable and easier to teach to students. This was a consistent pattern with most of the successful strategies that teachers tried.

Not all of the data were able to be evaluated using inferential statistics. However, the data paints a positive picture of the outcomes for students. The Fisher and Horton (unpublished) analysis gives a complete view of the ideal Dimensions classroom (see Appendix S) versus the typical classroom at Willow Creek in the observation data prior to implementation (see Appendix B).

The first stage of implementation was not enough to achieve total change. Stage II showed that those teachers who implemented the model at a high level got the best results. Stage I probably needed the positive reinforcement of the student gain which was demonstrated in Stage II.

Chicola (in press) demonstrated the positive effects of some Dimensions strategies on a specific content area, math problem solving. These strategies included metacognitive processes such as goal setting, planning, monitoring, and evaluating (see Appendix H).

Chapter 7

DECISIONS ON FUTURE OF INTERVENTION

Maintain, Modify, Abandon?

The project will be modified in several ways in 1992-1993. A committee of three primary teachers from the Dimensions study team and three intermediate teachers worked on a project for next fall that will facilitate the use of habits of mind by all of the staff. A timeline was completed whereby each behavior will be introduced by each staff member to students simultaneously. Those teachers who are most familiar with Dimension 5 will do training sessions for staff at faculty meetings. In 1991-1992 teachers were trained at the beginning of the year and at some faculty meetings, but still felt they needed the support of everyone introducing the same behaviors at the same time. This was in spite of the fact that there is not a preferred order of introduction.

Parents will be provided short "homework" sheets to help them to discuss the behaviors with their children and positively reinforce them when possible. Report cards will reflect student progress on goals related to habits of mind (see Appendixes J and T). Parents from the School Improvement Committee remarked that though the Dimension 5 behaviors had been introduced in the newsletters and at back-to-school nights, they probably would not provide sufficient home support until the behaviors were given importance by being assessed on the report card.

Bob Marzano and McREL have developed clear formats and examples of performance assessments based on the Dimensions model. These will assist in the needed refinement of those that were developed at Willow Creek in the 1991-1992 school year. Study teams should then be able to include as an integral part of the unit planning component. This will create a better match between the district goals and school goals.

Study teams will be formed with new teachers who are interested in implementing the model in their classrooms. A new position has been created for a staff development liaison, a teacher on staff who is also a liaison to the district in staff development. She will have the flexibility in her schedule to assist others on staff with implementation. This will greatly relieve the commitment time of the principal for coaching and modeling.

New study teams will benefit from the mistakes of the previous teams. The model will be introduced through unit planning; theory introduced where it is appropriate.

Study teams will be maintained in their current structure. By their nature, they are dynamic, depending on the needs and agendas set by the group as long as they remain accountable for meeting their goals. The principal will remain a member of these teams to give support, contribute ideas, listen, learn, provide leadership if it is appropriate, and follow the leadership of others where appropriate.

Dissemination of Information About Benefits

The ASCD research consortium was used to network with others involved in implementation of the model. ASCD has talked about a computer network which would connect interested schools. Willow Creek teachers helped ASCD in the development of a videotape which provides information to teachers throughout the world who are interested in Dimensions.

The author has presented workshops in Cherry Creek School District to interested schools and principals. Workshops have been conducted in other districts. The director of curriculum and the executive director of curriculum and instruction have met with the author concerning the evaluation results.

The final results of this MARP will be shared with Willow Creek staff and parents in September of 1992. The School Improvement Committee expects an updated report on new results.

McREL has committed to a continuing relationship with Willow Creek faculty. They will disseminate the results of this project to those requesting them who are interested in the Dimensions model.

The author assisted in compiling information for the article in Appendix A and intends to submit an article to Educational Leadership citing results of this study and information pertinent to the practical implementation of Dimensions at the elementary level. The author presented a workshop at the national ASCD conference in 1990, but will submit a proposal for an update session at the 1993 conference.

Recommendations

The Dimensions model has tremendous potential to influence the way students think and learn. This statement is most clearly supported by the Fisher and Horton analysis and results of the habits of mind questionnaire. If students are to be life-long learners, then learning and thinking must be viewed as something over which they exercise control. Teachers must become facilitators in the learning process rather than disseminators of content.

Our knowledge base is far too broad to teach students in kindergarten through grade twelve the "definitive curriculum," if such exists. Content is important, but not alone. Content must become a vehicle that assists students in learning how to access information, connect it with what is already known, assess it, organize it and store it so that it can be retrieved, and refine it and use it so that new and powerful connections are being made. Learning about content should be a positive experience that challenges students to think creatively, critically, and with self regulation.

Teachers should experience their own learning the way the Dimensions study team teachers did. They took identical information and experienced it in completely individual ways based on their previous experiences. They learned new strategies that helped them with their own learning. When they had personally experienced this new paradigm of learning and thinking, they were then ready to share it with students.

With the myriad of instructional approaches available to the practitioner, many teachers easily flit from one innovation to the next like a bee lighting on one flower, then another and another. The driving goal appears to be staying up with the newest trends rather than purposeful choice. Worse yet, other teachers are so inundated with the choices that they choose not to change at all. What is missing is an organizer, a context for choosing a new strategy because it evokes a certain kind of thinking and learning on the part of the student. The Dimensions model is that organizer. A teacher can choose to investigate cooperative learning because of its potential to improve students' attitudes toward learning and increase self regulation. Using the Dimensions model, the teacher can assess weak areas from the five dimensions and match these areas to Dimension strategies or other available instructional approaches. The program grid (see Appendix A) suggests a practical method for performing this match.

For the administrator who is responsible for supervision and teacher evaluation, this model serves a dramatic purpose. Most evaluation models require the supervisor to "checklist" teacher performance. Did the teacher follow the seven steps in the lesson planning format? Did the teacher use guided practice? Did the teacher build positive rapport with students? Did the teacher record grades appropriately? Are the bulletin boards cheerful? The list is endless, and most of the items probably represent components of good, researched teaching behaviors. The supervisor is spending so much energy looking at teacher behaviors that student behaviors are seldom noted. It is very possible that all of the seven steps in lesson planning format are present and students still are not acquiring or refining the content information.

Dimensions gives the administrator the same purposeful context that it gives teachers—a way to check on student learning and thinking behaviors in the classroom. In the classroom, observation strengths and weaknesses in student learning are noted. This data is then reviewed by the teacher and the administrator in an effort to problem pose. Alternative strategies for weak areas are generated, tried, and evaluated based on the effect on student learning. The Dimensions model provides a organized context and a common language to communicate about student learning. The administrator/teacher interaction is analogous to the study team process on a smaller scale. The interaction can be directive on the part of the supervisor, collaborative, or autonomous on the part of the teacher depending on the needs of that particular teacher (Glickman, 1985).

Teachers have flexibility and freedom of professional choice because Dimensions becomes the theoretical backdrop for informed choices. Optimum student thinking and learning are not negotiable; methodology, style, models of teaching, and all of the rest are negotiable. One of the most exciting side effects is that the adults begin by thinking about their own thinking and learning by studying the model and then begin to assist students in doing the same.

Study teams provide professionals the time to question, to pose problems, to plan, to set goals, to field mistakes in a safe environment, and to invest in their own growth. With the proper structure in place, teachers are excellent researchers of teaching and learning. Many teachers, and those at Willow Creek were no exception, have operated under the paradigm that the next researcher, a new program, better textbooks, and district staff developers will develop the definitive answer to solve problems of student learning. What study team members now realize is that experts and programs are good resources, but their own thinking is key to finding the best instructional match for students in their classrooms.

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ROBERT J. MARZANO, DEBRA J. PICKERING, AND RONALD S. BRANDT

Integrating Instructional Programs Through Dimensions of Learning

The "Dimensions" framework—based on general principles of how learning occurs—can be used to plan instruction, coordinate the use of various programs, and select and plan staff development activities.

Today's teachers have available an abundance of practices that can help them do a better job. Developers have designed and tested programs for maintaining discipline, motivating students, applying learning theory, encouraging cooperative behavior, teaching thinking skills, and so on. Unfortunately, many of these programs are seen as independent of one another, so they become bandwagons, each an isolated movement that lasts until the next one comes along. A teacher tries a little mastery learning for a while, then teacher expectations, then cooperative learning, then teaching thinking, and so on.

What is needed is a framework to integrate these programs: a tool that will help educators see how the various practices relate to one another. With such a framework, teachers will find it easier to blend several different programs, and administrators will be able to select and present various staff development efforts as a unified whole rather than as separate entities.

As we have worked with classroom teachers over the last two years to implement ASCD's *Dimensions of Thinking* (Marzano et al 1988), we have begun to see how the types of thinking discussed in that publication can be recast into such a framework.

Use of the framework will help teachers blend several different programs and administrators select and present various staff development efforts as a unified whole rather than as separate entities.

A Common Thread: Teacher Behavior

A thread running through most staff development programs is that teachers' actions are expected to produce certain types of thinking in students. If a teacher increases her physical proximity to a student who is misbehaving, the student may realize that he is breaking a classroom rule and correct his behavior; when a teacher asks a recall question, it cues students to search their memories for the requested piece of information.

This suggests that if we can identify the main types of student cognitions needed for various learning tasks, we can use the resulting scheme to classify the instructional practices featured in the leading inservice programs.

Some Principles of Learning

Unfortunately, student thinking doesn't occur in neat, easily identifiable categories. To guide our effort, therefore, we have identified four principles of human learning gleaned from current research and theory.

13?

Principle #1: Attitudes and Perceptions Affect Learning

Recent research in motivation (e.g., Harter 1982; McCombs 1986, Weiner 1972, 1983) indicates that a person almost always approaches a task with a set of accompanying attitudes and perceptions that greatly influence performance. When a student sits down to read a chapter in a text for a course she is studying, she approaches the reading task with certain attitudes about the value of the course, the value of the textbook, and her knowledge and ability relative to the content being studied. Some attitudes are conducive to learning, others work against it. If the student believes that the course is quite valuable because it will help her attain a personal goal, her attitude will positively affect her learning. Conversely, if she can't see the value of the course, her attitude will negatively affect her learning.

Principle #2: Learning Involves Acquisition of Two Kinds of Information

Knowledge can be divided into two basic types: declarative and procedural (Paris and Lindauer 1982, Paris et al. 1983). *Declarative knowledge* is concerned with who, what, where, and when; for example, information about who was involved in Watergate, what occurred, and where and when it occurred. Researchers commonly subdivide declarative knowledge into (in order of specificity) facts, time sequences, causal networks, problems/solutions, episodes, principles, and concepts.

Procedural knowledge is knowledge of "how to," such as how to write a research paper. Sometimes the components of procedural knowledge are represented as steps that must be applied in a particular sequence; for example, the algorithm for doing long division. Others are much more loosely ordered, for example, the procedure for reading a bar graph.

Content in any field can be subdivided into these two major types. A course in geography might include concepts and principles (declarative knowledge) about the distribution of land, along with processes (procedural knowledge) such as how to read a contour map.

The dimensions are most useful as a kind of metaphor to guide instruction.

Principle #3: Once Acquired, Knowledge Undergoes Changes

Much recent research sheds light on the specific cognitive operations involved in the initial acquisition of information (for a review, see Anderson 1983, Estes 1982). A key cognitive operation is *activating old knowledge* and using it to make sense of new information. For example, while watching a documentary on sharks, you use your previous knowledge about sharks to help you make sense of the new information.

Another cognitive operation used when initially learning new information is *organizing the information* in such a way as to associate it and make linkages with existing knowledge in long-term memory. This not only helps your understanding of the new information, but it also makes the information more retrievable for use at a later date.

But knowledge stored in the mind is not static. Over time it changes, sometimes quite unexpectedly. Rumelhart and Norman (1981) have identified three types of knowledge change: accretion, tuning, and restructuring. *Accretion* refers to changes in knowledge due to the gradual accumulation of information. *Tuning* refers to the creation of generalizations about existing information. (It is a much more global and radical form of change than accretion.) *Restructuring* is the most global and most radical form of change, involving the creation of entirely new structures either to augment or to replace the old structures.

Common to all theories of knowledge change is the idea that to change an existing knowledge structure, the learner must mentally process the information in new and unusual ways (for a review, see Vosniadou and Brewer 1987). For example, when a student compares two or more concepts in detail, even if he knows them fairly well, he will probably "learn" something new.

Perhaps the most change-producing cognitive function is the *actual use of knowledge* in meaningful ways. It is one thing to listen to or read instructions for how to use a computer word-processing program but another thing entirely to actually use the program to prepare a manuscript. Only through actual use do most people begin to understand how the system works, as they solve the frustrating problems they invariably encounter.

In summary, the continuum of knowledge development involves cognitive operations that the learner uses to *acquire* information, other operations that the learner uses to *refine* the information, and still other operations that the learner can employ to *make use of* the information in meaningful ways.

Principle #4: Effective Learners Exhibit Dispositions Associated with Critical, Creative, and Self-Regulated Thinking

Based in part on studies of capable thinkers, scholars have identified various qualities of desirable thinking, often referred to as critical and creative thinking. Perkins (1984), Ennis (1985), Glatthorn and Baron (1985), Lipman (1988), and Costa (1985), for example, cite numerous characteristics of "good" thinking, including:

- being aware of one's own thinking at any point in time,
- seeking accuracy in what one does,
- operating at the edge rather than the center of one's ability.

Operations such as these are sometimes referred to as *dispositions*, because a person who has formed desirable habits of mind is "disposed" to behave in these ways. Dispositions are not unconscious, good thinkers often strive quite deliberately to meet such standards, asking themselves, "Have I considered other points of view fairly?" "Have I examined enough alternatives?" These habits of mind, while not innate, can be internalized with practice and thus can become part of one's personality.

Principles of Learning into Dimensions of Learning

The four principles of learning can be used to identify types of student thought that need to occur for learning to take place. We might call them "Dimensions of Learning": types of cognition that facilitate learning. Our portrayal of these dimensions will imply a general pattern or sequence (first one type of thinking occurs, then another), but that should not be taken literally; the dimensions are most useful as a kind of metaphor to guide instruction. As we will demonstrate, they can also be used to help understand how various instructional programs are similar and different.

The five dimensions that spring from the principles of learning are: (1) thinking needed to develop positive attitudes toward learning, (2) thinking needed to initially acquire and integrate knowledge, (3) thinking needed to extend and refine knowledge, (4) thinking needed to make meaningful use of knowledge, and (5) thinking needed to develop desirable habits of mind. Although not a direct translation, these five dimensions are adapted from the ASCD-sponsored framework, *Dimensions of Thinking* (Marzano et al. 1988). Here is a brief explanation of each dimension.

Dimension 1: Thinking Needed to Develop a Positive Attitude Toward Learning

As summarized in the first principle of learning, an important factor in any instructional situation is the student's attitude. We have identified three categories of attitudes and perceptions especially relevant to learning: attitudes and perceptions about (1) self and climate, (2) self and others, and (3) self and the task.

Attitudes about self and climate include the learner's perceptions about safety, comfort, and order in the learning situation. One of the learner's first concerns is often his or her own safety and comfort. This point has been emphasized by learning theorists such as Maslow (1968) and Combs (1982), and reinforced by findings of the school climate studies of the 1970s (Denham and Lieberman 1980).

Another category of attitudes affecting learning is *attitudes about self and others*. Student tend not to learn well unless they feel accepted by the teacher and the other students. The research on teacher expectations (Good 1982, Good and Brophy 1972) has shown the importance of student perceptions of teacher acceptance, and research on cooperative learning (Johnson et al. 1984) has shown the importance of student perceptions of acceptance by their peers.

The final area of attitudes affecting learning has to do with *self and task*. The learner must believe that the task has value, that she has a fairly clear understanding of what is required, and that she has the ability to complete it; otherwise the task becomes a threat to her sense of competence (Covington 1983).

An effective classroom climate is practically invisible, but it doesn't happen by chance; it is crafted by the artful teacher in subtle but intentional ways.

To provide for this dimension, teachers need to be able to establish and maintain an appropriate environment for learning. For example, a teacher might reinforce effective attitudes about self and climate by occasionally greeting students at the door or by arranging the physical aspects of the classroom in such a way as to accommodate different learning styles. A teacher might reinforce effective attitudes about self and others by making sure he provides equal opportunities for students to answer questions (so that students have a sense of acceptance by the teacher) and by using cooperative learning (so that students develop a sense of community and peer support). A teacher might establish effective attitudes about self and task by structuring tasks for high success, using scaffolding with students who are having difficulty, and communicating to students a sense of confidence in their ability to accomplish classroom tasks.

An effective classroom climate is practically invisible, but it doesn't happen by chance; it is crafted by the artful teacher in subtle but intentional ways.

Dimension 2: Thinking Needed to Acquire and Integrate Knowledge

The second principle of learning discussed earlier makes a distinction between two kinds of knowledge important to any content area: declarative and procedural. The third principle of learning indicates that a learner changes knowledge over time rather than simply retaining it in the form in which it was first acquired. Putting these two principles together, the second dimension of learning deals with the acquisition and integration of both declarative and procedural knowledge. The mental processes involved in this second dimension can be subdivided into three types: (1) constructing meaning, (2) organizing content, and (3) storing or practicing.

Acquiring Declarative Knowledge

Constructing meaning refers to using

what is already known to make sense of what is to be learned. Research, particularly research in reading comprehension, has established numerous strategies that can be used to help students construct declarative knowledge. For example, in K-W-L (Ogle 1986) the learner begins by identifying what she knows about the topic (K = what I already *know*), and what she would like to know (W = what I *want* to know). She then reads (listens to, observes) the information and determines what she has learned (L = what I *learned*). The strategy involves the learner in actively constructing meaning for new information.

Organizing declarative knowledge involves making distinctions among the different types of important information taught in a lesson (e.g., facts, time sequences, causal networks, problem/solutions, episodes, concepts, principles). Making these distinctions is the key to effective learning of declarative information. Specifically, since much of the declarative information presented to students orally and in writing can be organized in a variety of ways, students need to be able to organize the content in a way consistent with the teacher's preferred method of organization. If a teacher does not explain his preferred method of organization before presenting information, the instruction will lack focus and will impose on the learner the burden of trying to figure out how to organize it.

Finally, *storing information* involves representing it in long-term memory in a way that makes it easily accessible at later times. Operationally, this involves use of techniques such as verbal rehearsal, imagery, mnemonics, and so on.

Acquiring Procedural Knowledge

Two of the processes needed to acquire procedural knowledge are similar to those involved in acquiring declarative knowledge. For example, when first learning how to read a particular type of graph, a learner might help construct meaning by activating what she knows about reading other types of charts or graphs, thus creating an initial model of the process involved. Operationally this might involve making a flowchart showing steps in the procedure.

Storage, however, is different for the two types of knowledge. Whereas declarative knowledge needs to be stored for easy retrieval, procedural knowledge must be practiced to the level of automaticity. Operationally, this means that the learner needs to practice the procedure long enough that he can perform it with relatively little effort or thought.

The second dimension of learning, then, is thinking that helps the learner initially acquire and integrate both declarative and procedural information. Cognitively, this requires the construction of meaning, the organization of information, and either storage or practice, depending on whether the information is declarative or procedural.

Dimension 3: Thinking Needed to Extend and Refine Knowledge

According to the third principle of learning, knowledge continues to undergo substantive change after it has been acquired. One might say that once it has been acquired, knowledge is then available for extension and refinement, which comes about through processing the information in new and unusual ways. We have identified eight such ways (fig. 1).

Each of the cognitive operations listed in Figure 1 can be used to engage the learner in such a way as to change his or her knowledge of the content. In a social studies class, for example, students might compare different forms of government (democracy and dictatorship) to discover new distinctions between them. Similarly, making deductions, such as anticipating future events or conditions based on current information, can help students better understand the information on which the deductions are made. In a science class, for example, students might make deductions about whales based on known principles about mammals to refine and extend their knowledge about mammals and whales.

We might point out that the cognitive operations listed in Figure 1 may also be used when initially acquiring knowledge. For example, when first learning about types of governments, students may engage to some degree in comparison, induction, deduction, and so on. At this stage, however, most such activity will be automatic and relatively unconscious. To extend and refine knowledge, these operations are used consciously, rigorously, and with greater complexity. For example, when students first learn about democracies and republics, they might think casually about similarities and differences be-

Fig. 1. Extending and Refining Operations

Comparing:	Identifying and articulating similarities and differences between bodies of information relative to their specific attributes.
Classifying:	Grouping items into definable categories on the basis of their attributes.
Inducing:	Inferring unknown generalizations or principles from observation or analysis.
Deducing:	Inferring unknown consequences and necessary conditions from given principles and generalizations.
Analyzing Errors:	Identifying and articulating errors in one's own thinking or in that of others.
Constructing Support:	Constructing a system of support or proof for an assertion.
Abstracting:	Identifying and articulating the underlying theme or general pattern of information.
Analyzing Value:	Identifying and articulating personal value and general value of information.

Fig. 2. Processes Involving the Meaningful Use of Knowledge

Oral Discourse:	The act of discussing a topic using specified conventions [illegible] clarity to and provide new insights into the topic of discussion.
Composing:	The act of creating a new product using known information [illegible]
Problem Solving:	The act of attaining a content-related goal by overcoming [illegible] obstacle.
Decision Making:	The act of selecting among seemingly equal alternatives.
Scientific Inquiry:	The act of identifying underlying principles relating [illegible] psychological phenomena, making predictions based on [illegible] ples, and then systematically testing the accuracy of those [illegible]

tween the two. To extend and refine these concepts, however, they would be asked to list these similarities and differences, perhaps using some type of graphic or matrix representation. The difference is a matter of degree, focus, and conscious use.

Dimension 4: Thinking Needed to Make Meaningful Use of Knowledge

Our ultimate purpose for teaching the various forms of knowledge is to prepare our students to be able to use that knowledge in meaningful ways. As we know, one of the best ways to ensure that students fully understand the knowledge is to arrange for them to *make use of it at the time they are learning it*. Because something is meaningful to a person only if it fits with his or her goals, effective teaching involves finding ways for students to relate school knowledge to their personal goals.

We might note that the extending and refining operations listed in Figure 1 are not commonly the focus of personal goals. People don't often compare just for the purpose of comparing, they don't abstract simply for the purpose of abstracting.

Some cognitive operations, though, are more goal-directed. These operations, which we assign to Dimension 4, are briefly described in Figure 2.

For example, we call the process for creating something new *composing*. *Problem solving* is a process used to change an unacceptable situation, *decision making* is used to select among alternatives, and *oral discourse* is used to clarify information.

The process of understanding physical and psychological phenomena and then using that understanding to make predictions about future phenomena is *scientific inquiry*. In school, a student might engage in scientific inquiry to try to understand readers' reactions to certain types of language in a piece of writing. The student could then use that knowledge to predict how various types of readers might react to other texts.

Because these processes are so clearly goal-oriented, teachers can improve student motivation by organizing instruction around them whenever feasible. For example, in a history class, students might compose essays describing the events that led up to the Cuban missile crisis. They might use decision making to analyze Kennedy's reasons for blockading the Soviet missile-bearing ships. Or they might engage in oral discourse to clarify some of the issues around the events leading up to the blockade.

To summarize, the classroom tasks that perhaps have the most potential for changing existing knowledge, especially when they are selected by students, are those that embody the processes listed in Figure 2.

Dimension 5: Thinking Needed to Develop Desirable Habits of Mind

The fourth principle of learning discussed earlier holds that good thinkers have certain "dispositions." These "habits of mind" include:

- being clear and seeking clarity,
- being accurate and seeking accuracy,
- being open-minded,
- taking a position and defending it,
- being sensitive to the level of knowledge and feelings of others,
- avoiding impulsivity.

Ennis (1985) has declared that these and similar behaviors are at the core of critical thinking. To illustrate, the learner might notice that she has a tendency to make bold assertions concerning topics she knows very little about and decide to begin trying to search her mind for evidence before she speaks. Another person might consciously strive to communicate in a clear fashion, checking to see whether others have understood his communication.

Another category of such characteristics is associated with creativity. Amabile (1983) and Perkins (1984) report that these include:

- engaging intensely in tasks even when answers or solutions are not apparent;
- pushing the limits of one's knowledge and abilities;
- generating and following one's own standards of evaluation,
- generating new ways of viewing situations outside the boundaries of standard conventions.

To illustrate, the learner might notice that she tends to "coast" through projects, expending as little energy as possible. To correct this tendency, she might "push" herself on a project, trying to do the very best she can.

The third category of desirable habits of mind are those that characterize self-regulated behavior. From research and theory in metacognition and self-efficacy (Brown 1978, Flavell 1976), we know that people can learn to:

- plan,
- be sensitive to feedback,
- use available resources,
- be aware of their own thinking,
- evaluate the effectiveness of their own thinking.

To illustrate, the learner might make a specific plan of action for an upcoming classroom project. As he implements his plan, he might occasionally note if he is getting closer to or further away from his goal and then make corrections as needed.

One of the biggest challenges teachers face is how to help their students develop the habits of mind associated with critical and creative thinking. Human history leads us to believe that young people develop these qualities by interacting with adults who model such behaviors and by consciously practicing them.

For example, a teacher might lead a discussion on a topic such as why the Supreme Court would uphold a person's right to burn the U.S. flag. Before the discussion, the teacher might remind students of the kinds of behaviors that help make for productive

Fig. 3. Comparison of Selected Programs on the Dimensions of Learning

Program*	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Dimension #1: Attitudes																				
1. Self and Climate	S	S	S	S	M	–	–	–	–	–	–	–	–	–	–	–	–	M	S	–
2. Self and Others	M	S	S	M	M	–	–	–	–	–	M	M	–	M	–	–	–	M	S	M
3. Self and Task	S	S	M	S	M	S	S	S	S	M	–	–	–	–	–	–	S	S	S	–
Dimension #2: Acquiring and Integrating Knowledge																				
1. Declarative																				
a. Constructing Meaning	S	M	S	S	S	S	S	S	S	M	–	–	–	–	–	S	M	S	S	M
b. Organizing	S	M	S	S	S	S	S	S	S	M	–	–	–	–	–	S	S	S	M	S
c. Storing	S	–	M	M	S	S	S	S	S	M	–	–	–	–	–	M	S	S	S	S
2. Procedural																				
a. Constructing Meaning	S	M	S	S	M	S	S	S	S	M	–	–	–	–	–	–	–	M	S	–
b. Organizing	S	M	S	S	M	S	S	S	S	M	–	–	–	–	–	S	M	S	M	M
c. Practicing	S	–	M	S	–	S	S	S	S	M	–	–	–	–	–	M	S	S	S	M
Dimension #3: Extending and Refining Knowledge																				
1. Comparing	–	–	–	–	S	–	–	M	S	S	M	M	S	S	M	M	M	M	S	S
2. Classifying	–	–	–	–	S	–	–	M	S	S	M	M	S	S	M	S	M	M	M	S
3. Inducing	–	–	–	–	M	M	M	M	M	S	M	M	S	S	M	M	M	M	S	M
4. Deducing	–	–	–	–	–	–	–	–	–	M	–	–	S	S	–	–	–	–	–	–
5. Analyzing Errors	–	–	–	–	S	–	–	–	–	S	M	M	S	S	M	–	S	–	–	–
6. Supporting	–	–	–	–	S	M	M	–	M	S	M	M	S	S	M	M	M	M	–	S
7. Abstracting	–	–	–	–	–	–	–	–	M	M	M	M	S	S	M	S	S	M	S	M
8. Analyzing Value	–	–	–	–	–	–	–	–	–	M	–	–	S	S	S	–	S	–	–	S
Dimension #4: Meaningful Use of Knowledge																				
1. Oral Discourse	–	–	–	–	S	–	–	–	–	–	M	–	S	S	–	–	–	–	–	–
2. Composing	–	–	–	–	–	–	–	–	M	M	M	M	–	–	–	–	M	–	–	–
3. Problem Solving	–	–	–	–	S	–	–	–	S	M	S	S	S	M	S	–	S	–	–	S
4. Decision Making	–	–	–	–	S	–	–	–	–	M	M	S	S	M	S	–	S	–	–	S
5. Scientific Inquiry	–	–	–	–	S	–	–	–	–	M	S	–	–	–	–	–	M	–	–	–
Dimension #5: Habits of the Mind																				
1. Critical	–	M	S	–	M	–	M	–	M	–	S	S	M	S	S	–	–	–	–	M
2. Creative	–	–	M	–	M	–	–	–	–	–	S	S	M	S	–	–	–	–	M	S
3. Self-Regulation	M	–	S	M	M	–	M	M	S	–	S	S	–	M	–	–	S	–	M	–

Key:
S = strong emphasis
M = moderate emphasis
– = relatively little emphasis

*Program Key:

A ITIP. Hunter 1969, 1976, 1982.
B TESA. Kerman, Kimball, and Martin 1980
C Cooperative Learning. Johnson and Johnson 1987; Slavin 1983, 1986.
D Mastery Learning. Bloom 1971; Block 1971, 1985; Guskey 1985.
E Models of Teaching. Joyce and Weil 1986.
F Explicit Teaching. Rosenshine 1986.
G Active Mathematics Teaching. Good, Grouws and Ebmeier 1983.
H BTES. Romberg 1980.
I Strategic Teaching. Jones, Palincsar, Ogle and Carr 1987.
J Bloom's Taxonomy: Cognitive Domain. Bloom, et al 1956.
K Olympics of the Mind. Gourley 1981.
L Future Problem Solving. Crabbe 1982.
M Project Impact. Winocur 1985.
N Philosophy for Children. Lipman, Sharp and Oscanyan 1980.
O CoRT. de Bono 1983, 1985.
P Strategic Reasoning. Upton 1961, Upton and Samson 1963.
Q Tactics for Thinking. Marzano and Arredondo 1986.
R The Skillful Teacher. Saphier and Gower 1986.
S 4MAT. McCarthy 1980.
T Teaching Styles and Strategies. Hanson, Silver and Strong 1986.

discussion. As the students expressed a variety of views on the issue, the teacher would ask for evidence, inquire about the premises underlying students' positions, and call attention to inconsistencies or irrelevancies. He might also reinforce desirable behaviors by judicious recognition and praise.

The final dimension of learning, then, is thinking characteristic of critical, creative, and self-regulated people. Like positive attitudes toward learning (Dimension 1), these qualities must be fostered in an indirect but conscious way. Whenever feasible, the teacher should overtly encourage self-regulated, critical, and creative thought.

The thinking we categorize as Dimension 5 is essential to effective performance of the kinds of thinking described in the other dimensions. For example, to make sound decisions, a person needs to exhibit objectivity and attention to evidence; to solve problems well, a person needs to produce imaginative solutions through habits of mind such as persistence and commitment to high standards.

In summary, the five dimensions represent the types of thinking that facilitate effective learning. They can be used to plan instruction that will improve students' success in mastering school content while also developing their cognitive skills.

Using the Dimensions as an Analytical Tool

The dimensions framework can also

be used to analyze and compare staff development programs and instructional practices. Specifically, one can determine which dimensions are emphasized in each program. Figure 3 is an analysis of 20 different programs from the vantage point of the five dimensions of learning.

In the figure, an *S* in any cell indicates *strong* emphasis on that dimension, an *M* indicates *moderate* emphasis, and a – indicates that the program puts relatively little emphasis on that dimension. This is not to say that the program or practice totally ignores that area (although it might), but only that in our judgment the program or practice does not overtly deal with that dimension. For example, Figure 3 indicates that the ITIP program (Column A) is strong in the "self and climate" and "self and task" components of Dimension 1 and moderate in the "self and other" component of that dimension. It is strong in all aspects of Dimension 2. However, even though some interpretations of the ITIP program use Bloom's (et al. 1956) taxonomy, which is strong in Dimension 3 (see Column J in fig. 3), the ITIP program per se does not directly address Dimensions 3, 4, and 5, except that it is moderately geared toward enhancing some of the habits of self-regulation in Dimension 5.

In addition to being used as a tool for analyzing various programs, the dimensions can be used as a vehicle for coordinating the use of programs. Specifically, it would seem highly advisable that a school or district select programs in such a way that they cover as many dimensions (with all of their subcomponents) as possible.

The five dimensions can be used to plan instruction that will improve students' success in mastering school content while also developing their cognitive skills.

The Dimensions in Practice

This article has described the dimensions as a theoretical framework that can be used for instructional planning and program coordination, but it is also a working model that has been field-tested in a number of situations. Specifically, two of the authors (Pickering and Davis) have field-tested the framework as an instructional model in an elementary school for a year. Use of the model appears to increase students' knowledge of content as well as their ability to use the array of cognitive operations needed to learn academic content. Their field-testing also disclosed that the teachers attended to Dimensions 1 and 2 in their instructional planning and implementation but infrequently addressed Dimensions 3, 4, and 5.

In addition to the field-testing that has already been done, ASCD has established a research and development consortium, which began in October 1989 and will end in August 1991, to test the effectiveness of about 200 strategies that have been incorporated in the model. Some 18 agencies, including 16 school districts from across the country, are participating in the consortium. ASCD also offers training in the Dimensions model as part of their National Training Center program each summer.

A Comprehensive Model for Teacher Education

The Dimensions model, which identifies five general types of thinking needed for effective learning, could eventually become the basis for a coordinated "curriculum" of preservice and inservice teacher education. At this point the model can be used to identify the cognitive focus of a number of existing staff development programs. Such an analysis allows educators to determine how these programs can be used in concert to promote student learning.□

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Authors' note. We would like to acknowledge the following as co-developers of the Dimensions of Learning framework Daisy E. Arredondo, Guy J. Blackburn, Deena L. Davis, and Robert W. Ewy.

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APPENDIX B

GROUPING, A PHILOSOPHICAL UMBRELLA

1. It is important to maintain flexibility so that students can make changes throughout the year as necessary.

2. Grouping patterns need to meet student needs.

3. Direct teaching time with students needs to be optimized given class size constraints.

4. The same group of students should not be kept together in the same class group year after year.

5. Heteorgenous groups should occur with the possible exceptions of homogenously grouping reading and math.

6. It seems appropriate to heteorgenously group according to some scheme rather than haphazardly.

7. Any system we use should maximize time on task.

8. Keeping track of past years groups from year to year will help us avoid #4,

APPENDIX C

STUDY GROUP QUESTIONNAIRE

Date 4-1-89 Group Dimensions Study Group

TEACHERS LISTED BY NUMBER

		1	2	3	4	5	6	7	8	Totals
REACTIONS TO THE STRATEGIES	Using strategies?						•	•	•	3
	Like strategies?	•	•	•	•	•	?	•	•	7
	Students like?	•	•	•	•	•	?	•	•	7
AREAS OF NEED EXPRESSED	Pressure to finish lesson.	•	•	•	•	•	•	•	•	8
	Feels "contrived".	•	•	•	•	•	•	•	•	8
	Need more practice.	•	•	•	•	•	•	•	•	8
	Need more modeling.	•	•	•	•	•	•	•	•	8
	Need observations.	•	•	•	•	•	•	•	•	8
	Student buy in hard.						•			1

Primary teachers = #1 - #4

Intermediate teachers = #5 - #8

Primary = grades 1,2,3
Intermediate = grades 4,5,6*

*Grade six moved to middle school after 1989

APPENDIX D

Figure I.2. Stages of Concern About the Innovation[2]

0 *AWARENESS*: Little concern about or involvement with the innovation is indicated.

1 *INFORMATIONAL*: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about herself/himself in relation to the innovation. She/he is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects, and requirements for use.

2 *PERSONAL*: Individual is uncertain about the demands of the innovation, her/his inadequacy to meet those demands, and her/his role with the innovation. This includes analysis of her/his role in relation to the reward structure of the organization, decision making, and consideration of potential conflicts with existing structures or personal commitment. Financial or status implications of the program for self and colleagues may also be reflected.

3 *MANAGEMENT*: Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, scheduling, and time demands are utmost.

4 *CONSEQUENCE*: Attention focuses on impact of the innovation on students in her/his immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.

5 *COLLABORATION*: The focus is on coordination and cooperation with others regarding use of the innovation.

6 *REFOCUSING*: The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.

[2] Original concept from Hall, G. E., Wallace, R. C., Jr., & Dossett, W. A. *A developmental conceptualization of the adoption process within educational institutions*. Austin: Research and Development Center for Teacher Education, The University of Texas, 1973.

CHERRY CREEK SCHOOL DISTRICT

THE SCHOOL'S 1990-91 PLAN FOR IMPROVING STUDENT ACHIEVEMENT

SCHOOL NAME Willow Creek

DATE: May 10, 1990

HIGH, BUT ACHIEVABLE GOAL STATEMENT: To improve students' incidence of higher order thinking behaviors in the areas of critical, creative, and self-regulated thinking.

DATA THAT SUPPORTS THE NEED FOR THIS GOAL: Data collected in study teams this year indicates that students are better at perceiving teacher cues rather than actually consistently demonstrating specifically defined thinking behaviors.

OBJECTIVES:	ACTIVITIES AND COST:	TIME LINE AND PERSON RESPONSIBLE	MEASURABLE EVIDENCE OF COMPLETION
Students will become familiar with the language of thinking.	Introduction and reinforcement in classrooms.	Staff at Willow Creek 1990-91 school year.	Teacher report. Informal testing (
Parents will be introduced to the language and behaviors of thinking reinforced at school.	Newsletter articles. pilot parent trainings.	Principal/Volunteer staff.	Articles/teacher report.
Students will demonstrate improved incidence of thinking behaviors.	Teaching the behaviors and reinforcing them.	Staff.	Sampling of teacher at various grades maintain anecdotal records.
To determine if report card evaluation of behaviors increases incidence.	Report cards printed.	Volunteer staff.	Teacher records/ report.

CHERRY CREEK SCHOOL DISTRICT

THE SCHOOL'S 1990-91 PLAN FOR IMPROVING STUDENT ACHIEVEMENT

SCHOOL NAME Willow Creek

DATE: May 10, 1990

HIGH, BUT ACHIEVABLE GOAL STATEMENT: Improve student retention of science and social studies concepts through curriculum realignment and introduction of Dimension of Learning strategies.

DATA THAT SUPPORTS THE NEED FOR THIS GOAL: District social studies test. Teacher generated tests.

OBJECTIVES:	ACTIVITIES AND COST:	TIME LINE AND PERSON RESPONSIBLE	MEASURABLE EVIDENCE OF COMPLETION
To teach students learning strategies which will improve understanding and long-term retention of curricular concepts.	Teaching strategies/study teams release time.	Volunteer teachers participating in project. 1990-91 school year.	Comparison betw[een] control group and participating group on test scores. Retesting after time lapse.

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APPENDIX F

CONSORTIUM REPORT FOR ASCD

Form D
Reporting Form

School/District: Willow Creek Elementary/Cherry Creek School District
Grade Level/Content Area: Grade Five, all subjects

Area worked on: Acquiring and Integrating Declarative Knowledge

Hypothesis: The science content typically has given students the most difficulty. Reading the textbook has been an obstacle for many and understanding the material has been generally poor. I wonder if using graphic organizers and teaching kids the strategies of KWL and reciprocal teaching would enable students to be more successful with the science content. The interest level has usually been low, and I predict that my plan will probably improve the interest that students have in science.

Effects on me: Terrific! My entire focus of how to plan the pollution unit has shifted in a much better direction than ever before. In order to plan a graphic organizer that I felt would be useful to the kids, I spent hours thinking about what part of the declarative knowledge would be primary and what would be secondary. My teammate and I developed the attached graphic organizers to give to the students

Effects on students: This was not the first time my class has worked with graphic organizers, so they had already had the background knowledge of the purpose they serve. I used the graphic organizer as we read the textbook, and we would discuss the material and complete the blanks as we went along in the unit. I had a substitute one day due to a study team meeting and I left very detailed plans about how and why I wanted her to coordinate the textbook material with the graphic organizer. The following day my class had numerous questions regarding the previous day's lesson, and one of them said," I didn't understand much yesterday. She told us to read these pages and then she told us what words to fill in the blanks. We finished way early and she read a book to us, but I like your way better. I don't get what we did yesterday."

I retaught the lesson and I could truly see the"cloud" lift from their faces as we continued. We had an excellent talk after about how much difference it makes if the teacher spends time with the organizer and relates it to their reading of text.

The class had also had some experience with KWL and reciprocal teaching, but I put much more emphasis on these strategies while increasing more independent reading of the text. One morning I had a cooperative learning lesson involving the textbook, graphic organizer, and other materials. Although all groups successfully completed the assignment, one group was not finished at the end of the period. I had been monitoring all groups and was very pleased with the group who had not finished because they had decided on their own to do a group KWL sheet before reading, and during the reading they were sharing the steps of reciprocal teaching It was extremely gratifying to watch this happen, to share it with the entire class later, and to hear those four students share how much "easier" their assignment was for them even though they took so much longer to finish.

Conclusion: My class is quite successful with graphic organizers; this past unit they developed their own for a part of the unit. When I require that they do KWL or reciprocal teaching, most can do well with them. I still struggle with getting more kids to use it more often of their own volition rather than by my directing it. However, this is gradually happening, and these particular Acquire and Integrate strategies have made a tremendous difference in their academic performance as well as a much higher interest in science. Yesterday I asked them to think about the unit we are presently working with, and figure out how it is similar to the pollution unit. I asked them to write their ideas on a piece of paper: 23 of the 27 wrote that both units have cause/effect relationships and that the causes are either natural or man-made. I am convinced that the mental pictures of the former graphic organizer attributed to such a high rate of accuracy.

Form D
Reporting Format

~~Name: Pat Lozier~~
Date: January 17, 1990
School/District: Willow Creek Elementary/Cherry Creek School District
Grade Level/Content Area: Grade Five; all subjects

Area worked on: Habits of Mind

Hypothesis : If I present lessons, discussion, and examples that demonstrate the three areas of Habits of Mind, I believe that the students will begin to show an awareness of them by exhibiting these behaviors in class.

What I did: I began by displaying the Critical Thinking Habits of Mind on an overhead so that the students could see the terminology while discussing it. Taking about twenty minutes a day, I gradually introduced each of the habits, providing examples and then asking the class to generate others. This was a slow process at first, but as we progressed, they became quite successful with their own examples. I spent approximately two weeks teaching about Critical Thinking and then began to verbally praise kids as I observed them using any of the six behaviors. With Debra's help during our study team meetings I was able to extend the praise by giving students a small certificate that had all of the Critical Thinking Habits of Mind printed. The certificates were something I valued as a reward and most of the class valued receiving them; I continue to encourage them to keep them in a safe place as they accumulate them.

When I felt that the class was comfortable and clear about Critical Thinking, I began the entire process again with Self-Regulated Habits of Mind. I did stress that although we were learning about new habits, we would continue to keep using and rewarding the Critical Thinking. In time, Creative Thinking Habits were introduced and discussed in the same manner.

Effects on me: In the effort to make the Habits of Mind a regular part of the school day, it heightened my awareness of the fact that some students were already using some by their own nature. This certainly helped create enthusiasm on my part to "use" these students as models of the habits whenever they occurred. I also noticed that I have planned my lessons so that they provide opportunities for students to practice these types of thinking.

For example, at the end of a pollution unit the kids were to collect trash that they found discarded on the ground. Each group was to create a large collage with their items and rate each item according to how harmful it could be to the environment. I inserted an additional task at this point, which was for the kids to keep a tally for how often they could not agree on a rating, and how often they resolved it by being open minded to various reasons given for a particular rating. I was very impressed how that focus enabled the groups to calmly problem solve rather than "bicker" and "attack". We did some group processing afterward and the students were able to identify open-mindedness as the key element causing the group to complete the assignment in such a positive way. I continue to work the Habits of Mind into many of my lessons now, and find that it greatly enhances the quality of thinking and interactions among students.

Effects on students: Although some children are aware and using the Habits of Mind to different degrees, I am pleased with the overall change I have seen. Several routinely use the terminology and show awareness by saying things like, "Didn't Jared just show seeking clarity?", or, "The whole class should get an orange certificate for that." At times during conferencing, I can say to a student,"Do you realize what you just did?" Many can respond with a correct recognition of "sticking with the task" or "being aware of my own thinking". Although some of the class can do this, it is evident that I have much more to do to increase the involvement of others. At the same time, when I think back to those first introductory lessons, I am extremely happy with their progress.

Conclusions: It is definitely essential that I continue to model, reinforce, and reward any Habits of Mind that the kids display. Although slower in progress, some of the less confident students are "taking risks" that they would not have in the past, like asking questions when confused. For most, the Habits of Mind have shifted the focus from "I can't" to "This is hard but I can do some things to help myself."

APPENDIX G

SELF SYSTEM STRATEGY DESCRIPTION

ATTITUDE

1. EFFORT PAYS OFF.
2. I "CAN" SOLVE THE PROBLEM.
3. BE PERSISTENT.
4. STRIVE TO WORK BEYOND WHAT YOU THINK YOU CAN DO.
5. BE AWARE OF AND USE THE RESOURCES AROUND YOU.
6. LEARN FROM FAILURE.
7. DON'T BE AFRAID TO MAKE MISTAKES.
8. MAINTAIN A POSITIVE ATTITUDE.

ATTENTION

1. BRACKET.
2. REMOVE DISTRACTING MATERIALS.
3. CREATE MIND PICTURES FOR THE PROBLEM.
4. MAKE YOURSELF UNCOMFORTABLE.
5. WRITE ANSWERS TO ANY QUESTIONS YOU HAVE.
6. TALK ALOUD ABOUT THE PROBLEM.
7. USE SELF-TALK.
8. TRY TO IGNORE OUTSIDE DISTRACTIONS.
9. REFRAIN FROM MAKING YOUR OWN DISTRACTIONS.
10. STICK WITH THE TASK.
11. ASK QUESTIONS.

COMMITMENT

1. DECIDE ON A SPECIFIC TIME AND PLACE TO COMPLETE THE PROBLEM.
2. TELL ANOTHER PERSON WHAT YOUR COMMITMENT IS.
3. WRITE YOUR COMMITMENT ON A PIECE OF PAPER.
4. MAKE A MIND PICTURE OF YOURSELF COMPLETING YOUR COMMITMENT.
5. ASK A FRIEND TO HELP YOU KEEP YOUR COMMITMENT.

APPENDIX H

TASK SYSTEM STRATEGY DESCRIPTION

PLANNING

1. READ THE PROBLEM.
2. DETERMINE WHAT YOU ARE ASKED TO FIND OR DECIDE.
3. LIST THE QUESTION(S) THAT NEED TO BE ANSWERED.
4. LIST THINGS THAT NEED TO BE CONSIDERED.
5. DECIDE WHAT DATA NEED TO BE COLLECTED.
6. ASK QUESTIONS.
7. TRY TO PUT IDEAS IN A LOGICAL ORDER.
8. MAKE SOMETHING WITH WHICH TO DISPLAY THE INFORMATION.
9. GATHER ANY NEEDED MATERIALS.
10. ASSIGN INDIVIDUAL TASKS IF NECESSARY.

MONITORING

1. CHECK YOUR PROGRESS TOWARD YOUR GOALS AND SUBGOALS.
2. CHECK TO SEE HOW CLOSE TO YOUR GOAL YOU ARE.
3. REVISE GOALS AND/OR STRATEGIES TO HELP SOLVE THE PROBLEM.
4. CHECK TO SEE THAT YOU ARE USING THE STRATEGY IN THE RIGHT WAY.
5. CHECK TO SEE IF YOU ARE USING THE CORRECT STRATEGY.
6. ACTUALLY WORK THE PROBLEM IN A LOGICAL ORDER.
7. CHECK TO SEE HOW CLOSE YOU ARE TO A SOLUTION.

EVALUATING

1. IDENTIFY PARTS OF THE SOLUTION THAT CAUSED DIFFICULTY.
2. IDENTIFY WAYS THAT THESE OBSTACLES COULD HAVE BEEN AVOIDED.
3. LIST SUGGESTIONS FOR SOLVING THE PROBLEM DIFFERENTLY.
4. IDENTIFY SIMILAR PROBLEMS SOLVED PREVIOUSLY.
5. FORMULATE SIMILAR PROBLEMS THAT MIGHT BE ENCOUNTERED IN THE FUTURE.

APPENDIX I

RESULTS AND CONCLUSIONS OF the PROBLEM SOLVING ASSESSMENT from **THE EFFECTS of METACOGNITIVE STRATGEY INSTRUCTION on SIXTH GRADER'S MATHEMATIC PROBLEM SOLVING ABILITY**

Problem-Solving Performance

Hypothesis 1

Training in metacognitive strategies enhances a sixth-grade student's ability to problem solve. Experimental Groups 1, 2, and 3, which receive metacognitive Self, Task, and a combination Self and Task System strategy training, respectively, will exhibit higher scores on the Five-Question Problem-Solving Assessment.

The means, standard deviations, and adjusted posttest means from the test of problem solving are displayed in Table 4.1. The scale on the Five-Question Problem-Solving Assessment ranged from a possible low score of 0 to a high score of 20 points. Table 4.2 shows the results of a 3 x 4 (level x treatment) ANCOVA performed on the test of problem solving, using pretest scores as the covariate.

The analysis revealed that there was a significant difference between the adjusted posttest means of the four treatment groups. The effect of treatment was statistically significant at the $p < .05$ level, $F(3,61) = 3.325$. The null hypothesis was rejected. Training in metacognitive strategies had a significant impact on students' problem-solving performance. When comparing the pretest and posttest

Table 4.1
Problem Solving Assessment
Means and Standard Deviations

Treatment	Pretest		Posttest		Adj. Posttest
	M	SD	M	SD	M
Control	6.00	2.54	11.11	3.58	11.01
Experimental 1	5.95	2.86	11.85	3.60	12.27
Experimental 2	5.86	2.29	13.05	4.24	13.55
Experimental 3	5.81	2.18	11.86	2.35	12.31

Table 4.2
Problem Solving Assessment
Summary of Analysis of Covariance

Source	Sum of Squares	*DF*	Mean Square	*F*	Significance of *F*
Level	91.761	2	45.881	7.980	.001
Treatment	57.355	3	19.118	3.325	.025
Level x Treatment	34.457	6	5.743	.999	.434
Cov: Pretest	261.963	1	261.963	45.565	.000
Residual	350.698	61	5.749		
Total	808.216	73	11.071		

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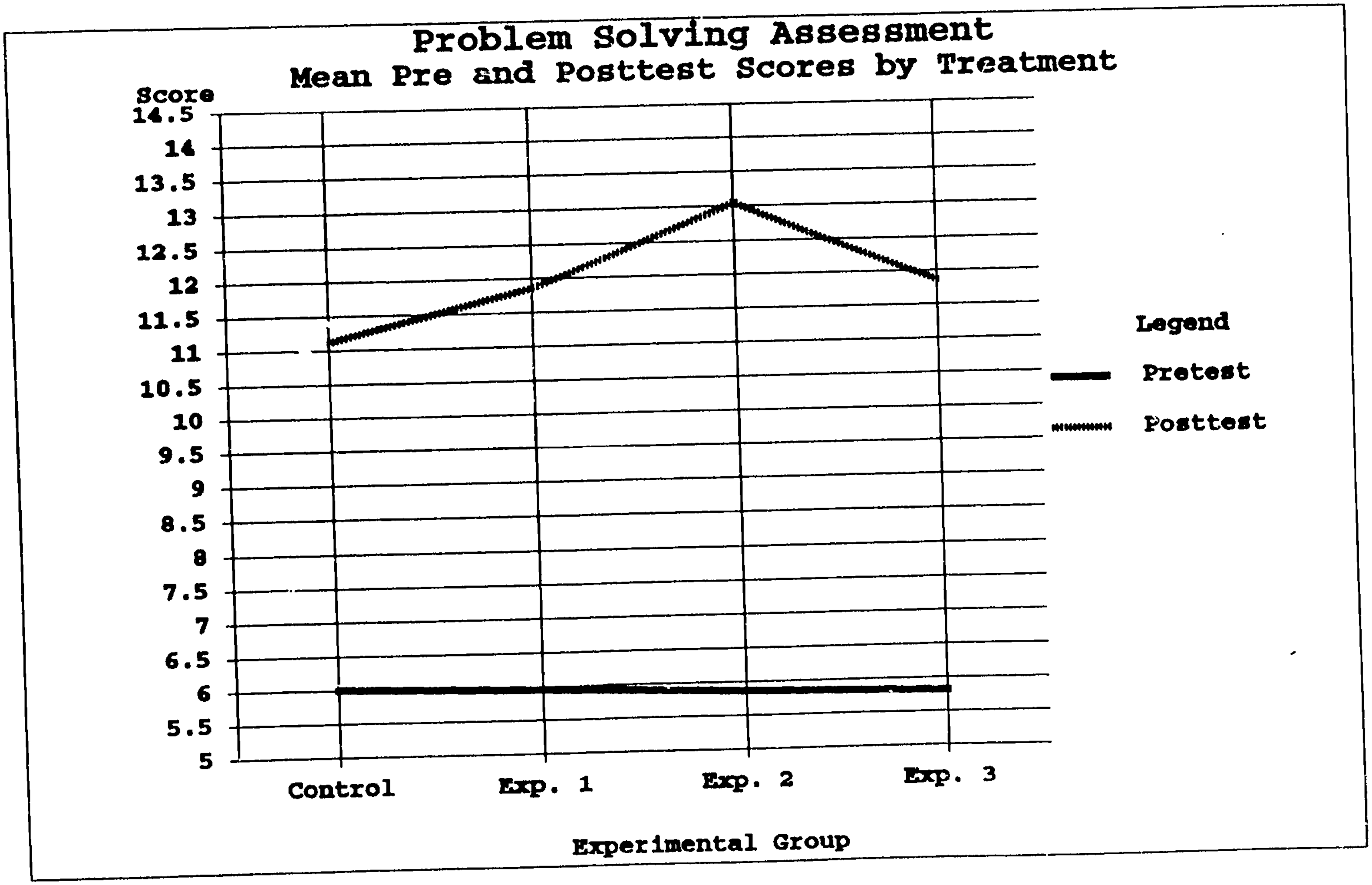
scores, it is apparent that this effect is due to the higher rate of improvement of the three experimental groups as compared to the control group. The Dunnett Multiple Comparison (*MC*) method was used for a planned pairwise contrast using the adjusted means and mean square error (MS_e) of the ANCOVA to compare each of the J - 1 means with one control group mean. The contrast of the combination of Experimental 1, Experimental 2, and Experimental 3 with the control group exceeded the critical value of t and the null hypothesis was rejected at $p < .05$ level. There was a marked improvement in the treatment groups that received Task System strategy instruction. Figure 4.1 graphically displays this relationship.

To further explore how the treatment groups differed, a planned comparison, Dunnett MC, was employed. The Dunnett MC provides a pairwise contrast to determine which means or groups of means are significantly different when compared to one predesignated mean, usually the mean of the control group. The Dunnett MC is a more powerful method of planned contrasts when comparing to one predesignated mean (Glass & Hopkins, 1984). Again, the MS_e and adjusted means derived from the ANCOVA were used to compute the planned comparison. Each of the experimental group means was compared individually to the control group mean. When the combination Self and Task System group (Experimental 3) was compared to the control group, the t-ratio of 1.63 was just below the critical t-ratio of 1.67; therefore, the null hypothesis cannot be rejected. Results from Experimental 3 did not differ significantly from the control group. When the Task System group

Figure 4.1



Problem Solving Assessment
Mean Pre and Posttest Scores by Treatment
Score
14.5
14
13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
Control
Exp. 1
Exp. 2
Exp. 3
Experimental Group
Legend
Pretest
Posttest

(Experimental 2) was compared to the control group, the *t*-ratio of 3.18 was well above the critical *t*-ratio 1.67; therefore, the null hypothesis is rejected. Those students receiving instruction in the Task System strategies performed significantly better on the Five-Question Problem-Solving Assessment than those subjects in the control group. When the Self System group (Experimental 1) was compared to the control group, the *t*-ratio of 1.54 was just below the critical *t*-ratio of 1.67; therefore, the null hypothesis cannot be rejected. Results from Experimental 1 did not differ significantly from the control group.

Hypothesis 2

Compared to students receiving only Self or Task System strategy training, the combination of general metacognitive Self System and Task System strategies enhances the mathematics problem-solving skills of students. Students in Experimental 3 will score significantly higher on the Five-Question Problem-Solving Assessment than either students in Experimental 1 or Experimental 2.

Although the effect of treatment was statistically significant at the $p < .05$ level, it is apparent from Figures 4.1 and 4.2 that Experimental 3 did not perform better than either Experimental 1 or Experimental 2. To further explore Hypothesis 2, a Dunnett MC technique was employed using the adjusted means and MS_e from the ANCOVA. When the combination of Self and Task System strategy instruction group (Experimental 3) was compared to the Self System group (Experimental 1) or

Conclusions

In summary, it is increasingly apparent that metacognition is important for successful mathematical problem-solving performance. What is not so clear is the relationship between problem-solving performance and control of Self System and Task System metacognitive strategies. The results of this study indicate that training in metacognition facilitates mathematics problem solving performance. The type of strategy training, whether Self or Task System, has a differential effect. A Task System oriented approach for teaching metacognition proved to be more effective in a short-term study than a Self System approach. When considering the importance of the components of metacognition it is clear from the present study that the Task System strategies of goal setting, planning, monitoring, and evaluating are highly implicated in problem-solving performance. Further, Task System strategy training influences attitude for low achievers and other achievement levels to varying degrees. Low achievers, when given the strategies to help them effectively solve problems, improve their attitude toward problem solving. The practical implications of this finding suggest that it may be more effective to provide Task System strategy training for students to provoke both a positive attitude toward problem solving and increased problem-solving performance. The metacognitive strategy training approach had no effect on high achievers suggesting that training is unnecessary, but not detrimental for this level of student. The precise role that Self System and Task System strategy training has in mathematical problem solving performance requires further explanation and, therefore, further investigation.

Implications for Teaching and Learning

The results of this study have three main implications for mathematics problem-solving instruction. First, this study demonstrates that teaching metacognitive strategies is an effective method for improving students' problem-solving performance. Second, the type of metacognitive strategy instruction provides varying degrees of effectiveness. An approach that focuses on the Task System strategies enhances students' mathematics problem-solving performance more than an approach that focuses only on the Self System strategies. Finally, instruction in the combination of Self and Task System strategies does not necessarily enhance performance over instruction in Task System strategies alone. Therefore, when developing a mathematics problem-solving curriculum, educators should provide explicit instruction in goal setting, planning, monitoring, and evaluating and integrate this instruction within the context of mathematics. Studies mentioned throughout this document indicate that metacognition is strongly related to problem-solving performance and should be included in any mathematics problem-solving curriculum.

The present study encompassed only 24 days of instruction. Given an extended span of time and greater concentration, training in the metacognitive Self System strategies of attention, commitment, and attitude may prove beneficial. The model for metacognitive learning created for this study can be used to help educators develop a comprehensive mathematics problem-solving curriculum that includes instruction about metacognitive strategies in both the Self and Task Systems.

The results of this experiment suggest that providing an instructional model for metacognitive training and explicitly linking this training to mathematics problem solving enhances sixth-graders ability to problem solve. Investigating the Self System and Task System aspects of metacognition have not been generally applied in the area of mathematics problem solving and this study provides one of the first examinations of these two variables and their importance to metacognition and problem solving ability. The present study adds to the literature on problem solving and metacognition by separating the Self and Task Systems in an attempt to further clarify the "fuzzy" concept of metacognition.

Recommendations for Future Research

The present study has provided data which shows that metacognition plays an important role in mathematics problem solving. More specifically, an attempt was made to clarify the role of Self and Task System strategy use and any interaction of these systems. This study creates many opportunities for future research.

More research into the interaction of the Self and Task Systems and their contribution to enhanced performance should be pursued. Since the duration of the present study was a mere 24 days, it is suggested that further research be of a prolonged duration in order to determine the full impact of both systems, especially the Self System.

Future researchers should take a closer look at the impact of metacognitive strategy instruction on students of varying ability levels (low, middle, high) to determine the effectiveness of this strategy training for each of these levels. The necessity of metacognitive training for students of high ability level must be considered.

Impending research should address the issue of attitude and its impact on problem solving performance and determine if attitude can be modified through experience with success after Task System strategy instruction. Since some researchers (Lester, Garofalo, & Kroll, 1989) emphasize the importance of attitude to success in problem solving and since those subjects in the Self System treatment group did perform better than the control group, investigation on how best to impact attitude is important.

END-OF-YEAR REPORT

WILLOW CREEK ELEMENTARY SCHOOL ACCOUNTABILITY COMMITTEE

by Chris Domino, PTO Representative
Deena Tarleton, Principal

Mission

The Accountability Committee is mandated by the state. Its purpose is to make sure that the school meets the needs of its community. The state requires certain goals in student achievement, attendance, and graduation, and requires that this committee write those goals, determine how to measure them, and publish them to the community and to the state. But beyond that requirement, the committee is free to take up any issue that concerns it and makes what recommendations it sees fit to the principal and faculty of the school.

Who Serves?

Anyone is welcome to come to the meetings or serve on the committee, but the state requires that the committee's membership reflect the ethnic and racial diversity of its community.

Highlights

We had a great year. Our new half-day meeting time allowed for more exchange and development of new ideas.

It's a little premature to report progress on our 1991-92 goals, since the Iowa Tests of Basic Skills will not be given until October of 1992.

Primary teachers are reporting good results on the end of the year assessments in reading. As you know, first and second grade has worked hard this year to implement a new reading program which combines small group instruction in reading strategies with teacher analysis of any weaknesses so that they can be eliminated.

Habits of Mind, critical, creative, and self-evaluative thinking behaviors, have been emphasized this year. By doing a sample survey of students, we discovered that those who understand the language of habits of mind also have a better understanding of the thinking behaviors. For next year, we plan to include habits of mind on all report cards and involve parents in helping us reinforce these behaviors.

The committee also spent a good deal of time sorting through what our priorities are and should be, especially in a time of budget shortfalls.

OVER...

I have listed below the major items we discussed. Our school improvement goals for the coming year are also included.

Areas of Work, 1991-92

1. Measuring how well the school does its job: survey of parents at conference time; survey of sixth-grade students and parents, etc.
2. Discussing better ways to communicate with parents and the community about the school, including such media as videotapes, and better ways to increase parent commitment to and involvement with the school.
3. Recommending the faculty discuss revision of the report card to include a habits of mind checklist.
4. Evaluating test results and questionnaires, especially considering some improvement of the science program.
5. Discussing alternate assessment vehicles; support for research projects that were implemented this year.
6. Discussing school calendar and possible revisions.
7. Considering ways to increase physical education participation.

School Accountability Goals for 1992-93

1. Continue to improve students' incidence of higher order thinking behaviors in the areas of critical, creative, and self-regulated thinking.

2. To maintain our present high level of 96% attendance. (A state-mandated goal)

3. By the end of third grade, students at Willow Creek will be at or above grade level in reading and will know strategies which will enable them to maintain this ability throughout their academic career.

4. Facilitate teachers in understanding the use of technology as a teaching/learning tool in the classroom.

5. Communicate appropriate developmental practices to parents of primary students.

6. Maintain student achievement in math concepts, problem solving, and computation at intermediate grade levels.

7. Instill respect for diversity and provide support for those who are "diverse."

BACK-TO-SCHOOL NIGHT

I. Introduction of the teachers.

II. Introduction of Sandy Magyar and Bev Luchini

III. Thinking: How Do We Know Students Are Getting Better At It?

Industry and business has demanded of schools that students be able to think critically and creatively and to be able to work cooperatively in groups to solve problems.

We are working hard at Willow Creek to make adjustments in our curriculum to help students increase their abilitites to think. I'd like to spend the next few minutes talking about what you can do at home to encourage your children and to cooperate with our efforts.

A copy of the article by Arthur Costa entitled "Thinking: How do we know students are getting better at it?" has been provided for you. I would like to give you some of examples of some of the behaviors you want your child to exhibit and how what you can do to model these for them.

*Work with a partner. Designate one person tc be A and the other to be B.
A solves the problem talking aloud to B. B listens for how A solves it.

Be honest, hcw many of you said, "I hate this kinds of problems, I never do well on them?
Who had to draw a picture?
It is frustrating for us to watch kids struggle with problems and often easier to give them the answers, but we are robbing them of the practice of thinking

PERSEVERING WHEN THE SOLUTION TO A PROBLEM IS NOT IMMEDIATELY APPARENT

Example: Modeling: (Balancing your checkbook, doing income tax (Think Aloud)
Practice: Collect riddles or problems to encourage perseverance.
Duck, corn, fox riddle.

DECREASING IMPULSIVITY

Example: Work with them when they are doing homework to make sure that they understand the directions before starting anything. Ask younger students to tell you their plan for accomplishing a chore before starting it.

FLEXIBILITY IN THINKING

Example: Elevator story. Several solutions to a problem.

METACOGNITION

When you were verbalizing the steps you used to solve the day after problem, you were using metacognition. You were aware of your thinking as you were performing a task. Many students and adults feel that thinking abilities are things with which you were born. In fact any of us can become more capable in areas of thinking by practicing new strategies. Next time you are solving a problem think out loud through the steps you use. Also have them tell you what they are thinking as they are solving a math problem or reading a story or beginning to write a letter.

I don't have time to illustrate all of the behaviors. Take some time to think about these and pick a few you want to reinforce. Maybe instead of rewarding your child for good grades you might want to consider going out for an icecream when you notice that he or she was able to generate several solutions for a problem or kept at the homework to understand it when it was initially frustrating.

I will be teaching a class for parents beginning in October if you are interested in other ways to help your children improve their thinking abilities.

IT'S FRUSTRATING TO WATCH KIDS REINVENT THE WHEEL, BUT WHAT WE NEED TO KEEP IN MIND IS THAT ALTHOUGH WE DO NOT NEED NEW WHEELS, WE DO NEED NEW INVENTORS.

The Waggler
Willow Creek Elementary School — PTO Newsletter
7855 S. Willow Way, Englewood, CO 80112 773-1765
September 6, 1990

WEEKLY CALENDAR

Thursday, September 6	Back to School Night
Friday, September 7	10:00 a.m. - PTO Executive Committee - Conference Room
Tuesday, September 11	School Pictures 7:00 p.m. - PTO Meeting - Cafeteria
Friday, September 14	NO SCHOOL

FROM THE PRINCIPAL

Willow Creek has been involved in a project called Dimensions of Learning for two years. One of the purposes of this program is to help students to understand how they learn. One part of this is to understand some habits the mind can develop which will lead your child to be a more critical, creative and self-regulated thinker.

Throughout the year, I will be sharing with you some things you can do to reinforce these "habits of mind" at home.

The self-regulated habits of thinking include:

- Being aware of your own thinking
- Planning
- Being aware of necessary resources
- Being responsive to feedback
- Evaluating the effectiveness of your actions

Here is a way you could help to reinforce with your own children: being aware of your own thinking. This weekend my husband and I were trying to hang a very heavy painting in a place where there was not a stud. My children were watching and listening as we both talked aloud through several solutions to the problem. Some were obviously better than others.

The point is, we often work on a project or solve a problem silently. If we can "think aloud" through that process our children will become more aware of ours and their own thinking. Ask them to "think aloud" as they work on a project - you might be very surprised!

Set a goal to "think aloud" at least twice this week. Tell your spouse what you are doing and why. Get them involved if possible. Say to your children "I want you to become more aware of your own thinking, so I am going to think aloud myself."

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The Waggler

Willow Creek Elementary School — PTO Newsletter
7855 S. Willow Way, Englewood, CO 80112 773-1765

September 13, 1990

WEEKLY CALENDAR

Friday, September 14	NO SCHOOL
Tuesday, September 18	7:45 a.m. - Student Council Meeting Spruce

FROM THE PRINCIPAL

Last week I discussed the importance of reinforcing with children self-regulated thinking. Below are some behaviors which self-regulated thinkers habitually exhibit.

- Being aware of your own thinking
- Planning
- Being aware of necessary resources
- Being responsive to feedback
- Evaluating the effectiveness of your actions

Planning is a kind of thinking which often improves the quality of the things we do. Planning involves thinking through what one is going to do prior to beginning. It also involves evaluating previous experiences, learning from them and using that information to do better planning the next time.

Think of some personal experiences where planning really paid off or where lack of planning was disastrous. Share these with your kids. Involve them in family goal setting.

Kids are often involved in a myriad of after-school activities. Are they involved in planning their time to limit television watching, getting homework done, reading, and prioritizing sports and other activities?

Is the planning recorded in an organized way? If you anticipate going on a trip, have your children gather information and help in the planning.

If you observe times when your child planned well, say "That's great, planning is an important thinking habit you will need for life!"

These suggestions sound simple, but your spending the time to reinforce habits of thinking at home will help our efforts at school.

NEWS FORM P.E.

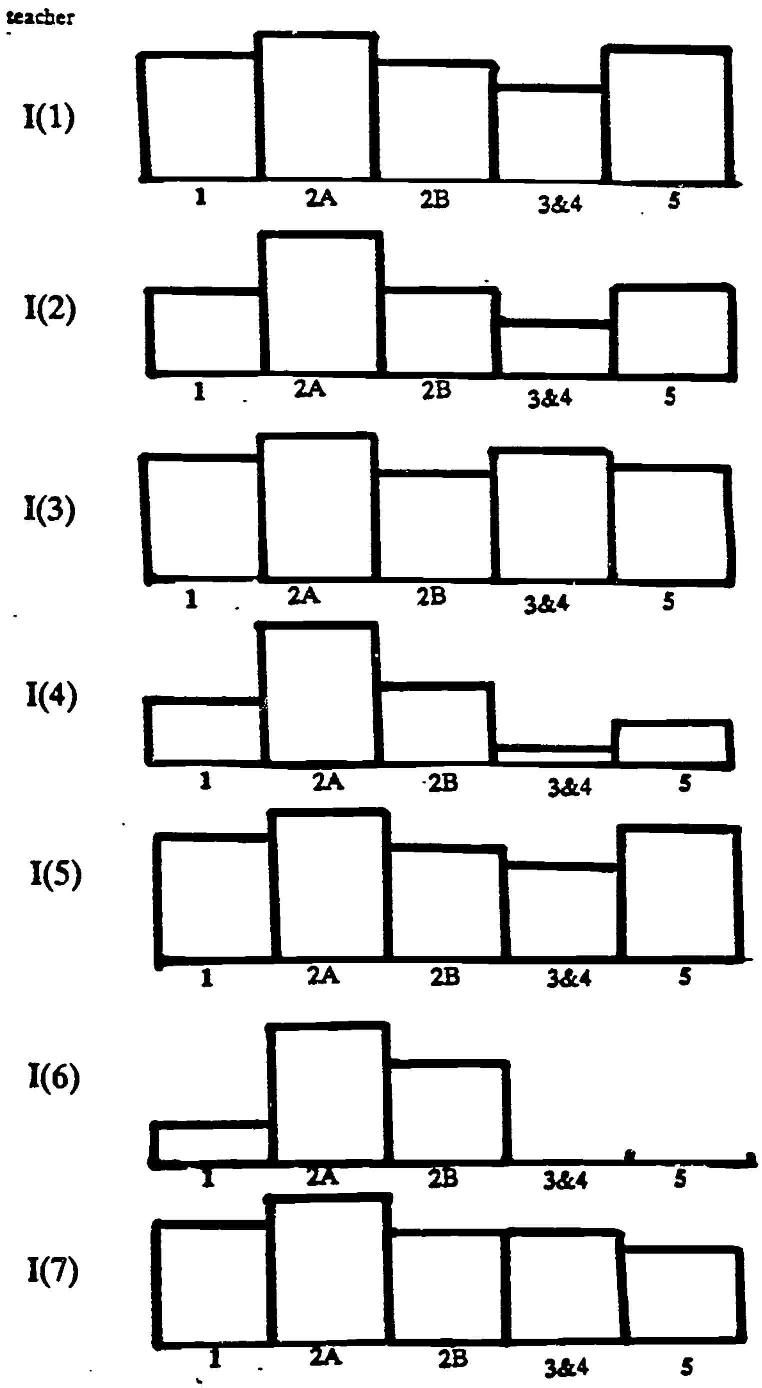
This year your child will be participating in a new fitness test/program during Physical Education. Children in grades 1-6 will take the Fitnessgram. It is a "state-of-the-art" youth fitness test and report system. It really is more than just a test. Following participation in a health-

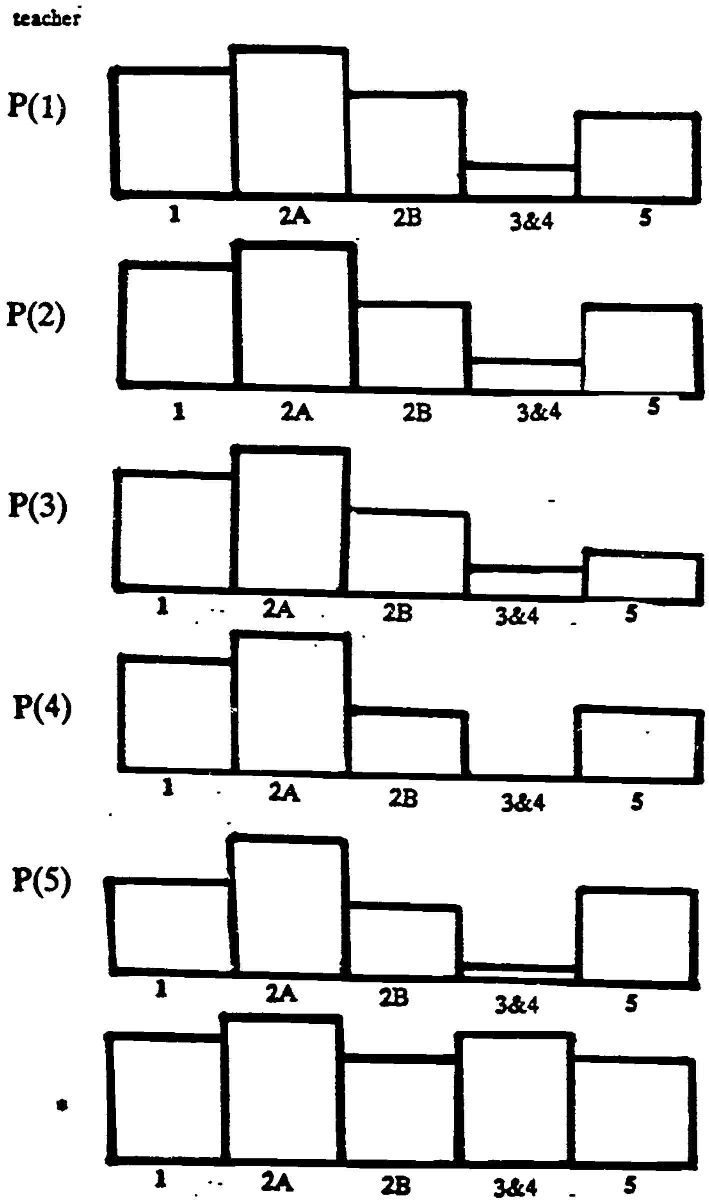
APPENDIX M

TEACHER OBSERVATION GRAPHS 1991-92

Time Allotment in Five Dimensions
(Vertical axis represents time)

1 = ATTITUDES AND PERCEPTIONS
2A = CONSTRUCTING MEANING AND ORGANIZING
2B = STORING
3&4 = REFINING AND USING
5 = HABITS OF MIND





*This represents a generalization of observations made of the above 12 teachers when they used the unit planning model

I = Intermediate teacher grade 4 or 5
P = Primary teacher grade 1 or 2

APPENDIX N - GROUP I 1989 ITBS SCORES

Building: WILLOW CREEK
Bldg. Code: 076 Page: 9
System: CHERRY CREEK SCHOOLS
Level: 11 Form G Grade: 5
Norms: MID-YEAR
Order No: 302-004752-003

Iowa Tests of Basic Skills

SERVICE 3:
BUILDING CRITERION-REFERENCED SKILLS ANALYSIS

	LISTENING LI	WORD ANALYSIS WA	VOCABULARY V	READING R	LANGUAGE SKILLS: SPELLING L-1	CAPITALIZATION L-2	PUNCTUATION L-3	USAGE L-4	TOTAL L	WORK-STUDY SKILLS: VISUAL MATERIAL W-1	REFERENCES W-2	TOTAL W	MATHEMATICS SKILLS: CONCEPTS M-1	PROBLEMS M-2	COMPUTATION M-3	TOTAL M	COMPOSITES: BASIC	COMPLETE	SOCIAL STUDIES SS	SCIENCE SC
COUNT			82	82	82	82	82	82	82	83	83	83	82	81	81	81	78	78		
AVERAGE GRADE EQUIVALENT			68.2	70.5	66.0	61.7	63.8	72.7	66.0	70.0	67.4	68.7	68.0	65.0	57.7	63.7	67.2	67.6		
PR OF AVG GE: PUPIL NORMS			82	83	73	65	70	81	75	84	78	83	83	78	61	79	82	82		
PR OF AVG GE: SCHOOL NORMS			95	97	92	77	83	95	90	97	94	96	96	95	76	94	96	97		

SKILLS	Building Count	System Count	Number of Items	Building Average Number Attempted	Building Average Number Correct	Building Average Percent Correct	System Average Percent Correct	National Average Percent Correct
VOCABULARY	82,	523	39	39	30	76	71	55
Reading/Language			8	8	6	80	78	61
Work-Study/Social Studies			16	16	11	71	68	53
Mathematics/Science			6	6	5	76	69	51
Fine/Applied Arts			6	6	5	84	79	61
Unclassified			3	3	2	72	63	49
READING	82,	522	54	53	42	77	73	58
Facts			17	17	14	80	75	61
Description/Categorization			6	6	5	85	83	68
Relationships/Context Meaning			11	11	8	77	71	57
Inferences			17	17	13	77	72	58
Cause and Effect/Conclusions			11	11	8	75	70	58
Traits and Feelings/Motives			6	6	5	79	76	59
Generalizations			20	20	15	75	71	55
Main Idea/Organization			6	6	5	81	78	64
Application/Purpose/Viewpoint			5	5	4	76	74	55
Language/Mood/Style			9	9	6	70	65	49
SPELLING	82,	523	40	40	27	68	66	55
Consonant Substitutions/Reversal			8	8	6	79	76	64
Consonant Omissions/Additions			13	13	8	58	59	49
Vowel Substitutions/Reversals			8	8	6	73	71	62
Vowel Omissions/Additions			6	6	4	67	63	50
No Mistakes			5	5	4	71	62	53
CAPITALIZATION	82,	522	30	30	19	65	66	57
Names and Titles			5	5	3	69	71	59
Dates and Holidays			5	5	3	64	67	61
Place Names			5	5	3	58	62	54
Organizations and Groups			6	6	3	54	58	51
Linguistic Conventions			4	4	3	68	67	57
Overcapitalization/No Mistakes			5	5	4	79	72	60
PUNCTUATION	82,	522	30	30	19	62	62	52
Use of Terminal Punctuation			9	9	5	61	61	49
Use of Commas			8	8	6	69	70	53
Use of Other Punctuation			5	5	2	49	52	52
Overpunctuation			5	5	3	67	64	48
No Mistakes			3	3	2	62	61	64
USAGE and EXPRESSION	82,	522	38	38	30	79	75	59
Use of Verbs			8	8	7	83	78	60
Use of Personal Pronouns			3	3	2	80	77	62
Use of Modifiers			5	5	4	75	70	51
Use of Context/No Mistakes			6	6	4	75	71	56
Conciseness and Clarity			3	3	2	80	76	61
Appropriateness			7	7	5	78	74	62
Organization			6	6	5	81	75	62

SKILLS	Building Count	System Count	Number of Items	Building Average Number Attempted	Building Average Number Correct	Building Average Percent Correct	System Average Percent Correct	National Average Percent Correct
VISUAL MATERIALS	83,	523	43	43	32	73	68	55
Map Reading			27	27	21	78	73	59
Locating/Describing Places			10	10	8	82	77	61
Determining Direction/Distance			6	6	4	73	70	56
Interpreting Data			3	3	2	67	59	46
Inferring Living Conditions			8	8	7	82	77	63
Reading Graphs and Tables			16	16	10	65	60	48
Reading/Comparing Quantities			9	9	6	69	63	51
Interpreting Relationships			7	7	4	59	56	44
REFERENCE MATERIALS	83,	526	40	40	32	81	76	62
Alphabetizing			8	8	6	79	77	60
Using a Table of Contents			7	7	5	75	73	60
Using an Index			7	7	6	92	90	79
Using a Dictionary			8	8	6	77	72	59
Encyclopedias/Guide & Key Words			4	4	4	89	81	62
General Reference Materials			6	6	4	74	65	51
MATH CONCEPTS	82,	528	35	35	25	71	68	56
Numeration and Number Systems			7	7	5	72	72	61
Equations and Inequalities			4	4	3	68	67	55
Whole Numbers: Integers			8	8	6	77	73	62
Fractions			5	5	3	68	62	47
Decimals, Currency, Percent			4	4	2	58	55	47
Geometry and Measurement			7	7	5	73	70	56
MATH PROBLEM SOLVING	81,	526	27	27	19	70	67	52
Single-Step: Add and Subtract			7	7	5	76	75	60
Single-Step: Multiply and Divide			9	9	6	66	65	49
Multiple-Step Problems			11	11	8	69	64	48
MATH COMPUTATION	81,	526	39	37	27	70	70	64
Whole Numbers: Add/Subtract			15	15	12	79	78	75
Whole Numbers: Multiply/Divide			16	15	11	68	70	62
Fractions: Add/Subtract			4	3	2	48	48	40
Decimals: Add/Subtract			4	3	2	62	65	58
OPTIONAL TESTS								
SOCIAL STUDIES	0,	0	42					45
Historical Perspective			16					45
Patterns and Systems			26					45
SCIENCE	0,	0	42					44
Nature of Science/Life Science			11					45
Earth and Space Science			12					38
Physics/Chemistry			7					40
Health and Safety			12					51

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APPENDIX O - GROUP II 1990 ITBS SCORES

WILLOW CREEK
076 Page: 37
System CHERRY CREEK SD
Level 11 Form G Grade 5
Norms FALL
Order 302-025640-009

Iowa Tests of Basic Skills

SERVICE 3:
BUILDING CRITERION-REFERENCED SKILLS ANALYSI

	LISTENING Li	WORD ANALYSIS WA	VOCABULARY V	READING R	SPELLING L-1	CAPITALIZATION L-2	PUNCTUATION L-3	USAGE L-4	LANGUAGE TOTAL L	VISUAL MATERIAL W-1	REFERENCES W-2	WORK-STUDY TOTAL W	CONCEPTS M-1	PROBLEMS M-2	COMPUTATION M-3	MATH TOTAL M	COMPOSITES BASIC	COMPOSITES COMPLETE	SOCIAL STUDIES SS	SCIENCE SC
NCNT			79	80	81	81	81	81	81	83	83	83	82	82	82	82	76	76		
AVERAGE GRADE EQUIVALENT			62.7	65.8	57.2	57.1	59.6	66.6	60.1	64.8	62.8	63.8	59.9	59.3	53.5	57.5	61.1	62.1		
PR OF AVG GE: PUPIL NORMS			78	81	63	62	67	77	69	81	76	80	74	71	57	71	76	78		
PR OF AVG GE: SCHOOL NORMS			92	95	73	71	79	92	83	94	93	95	88	88	65	85	90	93		

SKILLS	Building Count	System Count	Number of Items	Building Average Number Attempted	Building Average Number Correct	Building Average Percent Correct	System Average Percent Correct	National Average Percent Correct
VOCABULARY	79,	1200	39	38	27	68	67	51
Reading/Language			8	8	6	71	73	56
Work-Study/Social Studies			16	16	10	64	63	48
Mathematics/Science			6	6	4	64	62	47
Fine/Applied Arts			6	6	5	81	77	55
Unclassified			3	3	2	62	64	46
READING	80,	1204	54	53	39	71	68	54
Facts			17	17	13	75	70	57
Description/Categorization			6	6	5	82	79	64
Relationships/Context Meaning			11	11	8	72	66	53
Inferences			17	17	12	70	67	55
Cause and Effect/Conclusions			11	11	8	69	66	55
Traits and Feelings/Motives			6	6	4	74	71	55
Generalizations			20	20	14	69	66	51
Main Idea/Organization			6	6	5	79	76	61
Application/Purpose/Viewpoint			5	5	4	72	68	51
Language/Mood/Style			9	9	5	61	59	44
SPELLING	81,	1204	40	39	23	58	59	52
Consonant Substitutions/Reversals			8	8	6	71	70	59
Consonant Omissions/Additions			13	13	6	48	53	46
Vowel Substitutions/Reversals			8	8	6	69	67	59
Vowel Omissions/Additions			6	6	3	51	55	46
No Mistakes			5	5	3	53	55	50
CAPITALIZATION	81,	1204	30	30	18	60	63	54
Names and Titles			5	5	3	67	70	57
Dates and Holidays			5	5	3	61	65	58
Place Names			5	5	3	50	59	50
Organizations and Groups			6	6	3	46	53	47
Linguistic Conventions			4	4	2	60	65	54
Overcapitalization/No Mistakes			5	5	4	76	71	57
PUNCTUATION	81,	1205	30	30	17	57	60	48
Use of Terminal Punctuation			9	9	5	58	60	46
Use of Commas			8	8	5	60	67	49
Use of Other Punctuation			5	5	2	44	50	47
Overpunctuation			5	5	3	64	61	45
No Mistakes			3	3	2	58	58	63
USAGE and EXPRESSION	81,	1202	38	38	28	73	71	56
Use of Verbs			8	8	6	76	76	56
Use of Personal Pronouns			3	3	2	77	75	59
Use of Modifiers			5	5	3	61	65	47
Use of Context/No Mistakes			6	6	4	71	69	54
Conciseness and Clarity			3	3	2	77	73	59
Appropriateness			7	7	5	71	69	59
Organization			6	6	5	78	72	59

SKILLS	Building Count	System Count	Number of Items	Building Average Number Attempted	Building Average Number Correct	Building Average Percent Correct	System Average Percent Correct	National Average Percent Correct
VISUAL MATERIALS	83,	1207	43	43	29	67	65	[illegible]
Map Reading			27	27	19	72	71	[illegible]
Locating/Describing Places			10	10	8	75	74	[illegible]
Determining Direction/Distance			6	6	4	69	66	[illegible]
Interpreting Data			3	3	2	59	59	[illegible]
Inferring Living Conditions			8	8	6	76	74	[illegible]
Reading Graphs and Tables			16	16	9	59	56	[illegible]
Reading/Comparing Quantities			9	9	5	61	59	[illegible]
Interpreting Relationships			7	7	4	55	53	[illegible]
REFERENCE MATERIALS	83,	1203	40	40	30	75	72	[illegible]
Alphabetizing			8	8	6	75	70	[illegible]
Using a Table of Contents			7	7	5	75	70	[illegible]
Using an Index			7	7	7	94	88	[illegible]
Using a Dictionary			8	8	6	70	69	[illegible]
Encyclopedias/Guide & Key Words			4	4	3	73	72	[illegible]
General Reference Materials			6	6	4	63	60	[illegible]
MATH CONCEPTS	82,	1204	35	35	21	61	63	[illegible]
Numeration and Number Systems			7	7	4	64	69	[illegible]
Equations and Inequalities			4	4	2	55	63	[illegible]
Whole Numbers: Integers			8	8	5	62	68	[illegible]
Fractions			5	5	3	57	59	[illegible]
Decimals, Currency, Percent			4	4	2	56	53	[illegible]
Geometry and Measurement			7	7	5	67	65	[illegible]
MATH PROBLEM SOLVING	82,	1205	27	27	16	60	61	[illegible]
Single-Step: Add and Subtract			7	7	5	74	70	[illegible]
Single-Step: Multiply and Divide			9	9	5	57	58	[illegible]
Multiple-Step Problems			11	11	6	55	58	[illegible]
MATH COMPUTATION	82,	1205	39	36	24	62	65	[illegible]
Whole Numbers: Add/Subtract			15	15	12	79	77	[illegible]
Whole Numbers: Multiply/Divide			16	15	8	51	61	[illegible]
Fractions: Add/Subtract			4	3	1	37	41	[illegible]
Decimals: Add/Subtract			4	3	3	65	60	[illegible]
HIGHER ORDER THINK SKILL	76,	1169						
Reading Comprehension			32	31	22	69	66	[illegible]
Language Usage/Expression			29	29	20	70	69	[illegible]
Work Study Skills			46	46	31	67	65	[illegible]
Mathematics			19	19	10	54	57	[illegible]
SOCIAL STUDIES	0,	2	42				21	[illegible]
Historical Perspective			16				28	[illegible]
Patterns and Systems			26				17	[illegible]
Higher Order Thinking Skills			18				17	[illegible]
SCIENCE	0,	0	42					[illegible]
Nature of Science/Life Science			11					[illegible]
Earth and Space Science			12					[illegible]
Physics/Chemistry			7					[illegible]
Health and Safety			12					[illegible]
Higher Order Thinking Skills			18					[illegible]

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Appendix P

Scoring Rubric and Questions for Colonies Retention Test

Question: Discuss five important things that you learned about Colonial American.

Scoring Rubric:

6 Chooses important events or facts and specifically identifies their significance

5 Chooses important events or facts/does not explain their significance

4 Chooses some important events of facts with some explanation

3 Chooses some important facts or gives great detail about facts/events

2 Chooses facts with some detail but not related to each other and are not significant

1 Chooses bare facts; they are often wrong or not related to Colonial America

Appendix Q

Scoring Rubric and Question for Solar System Retention Test

Question: Discuss five important things you learned about the solar system.

Scoring Rubric:

5 Explanation includes facts/generalizations with elaboration or broad concepts with elaboration

4 Explanation includes facts with elaboration

3 Explanation includes broad concepts with not substantiation of knowledge of those concepts

2 Explanation includes minor concepts or facts with little or no elaboration

1 Explanation is vague or incorrect

Appendix R

Scoring Rubric and Questions for Respiratory Application Test

Questions:

Mr. Smith and Mr. Jones both had surgery. After the surgery, Mr. Smith recovered much faster than Mr. Jones. He began to feel stronger and the rosy color came back to his skin very quickly.

1. Explain how the heart and lungs work together.
2. Describe what might be different in Mr. Smith's circulatory and respiratory systems that would cause him to get back his rosy color faster than Mr. Jones.
3. What are two possible reasons that Mr. Smith's and Mr. Jones' heart and lungs were different?
4. How could you ind out for sure if one of your ideas is really the reason?

Scoring Rubric:

Question #1:

5 Detailed explanation of relationship of heart and lung including exchange of gases, heart as a pump for blood, anatomy details

4 Detailed explanation of relationship of heart and lung including either exchange of gases or heart as pump and anatomy details

3 Partial explanation of relationship of heart and lung including some information about anatomical structure,exchange of gases, or heart as pump for blood to lung

2 Sketchy explanation in one or more of the categories

1 Explanation contains one or two minor facts, misinformation, or no information

Question #2

5 Explanation contains three or more predictions based on in-depth knowledge of the circulatory and respiratory systems.

4 Explanation contains one or two predictions based on in-depth knowledge of the circulatory and respiratory systems.

3 Explanation contains one or two ideas with minor substantiation from a knowledge of the circulatory and respiratory systems.

2 Explanation is a best guess with no substatiation

1 Explanation is incorrect or missing

Question #3

Same as Question #2

Question #4

5 Answer contains several hypotheses showing in-depth knowledge with a description of the a testing process similar to experimental inquiry

4 Answer contains several hypotheses showing a good knowledge base with suggestions of several resources that could be used to verify the hypotheses

3 Answer contains one explanation or two explanations showing some knowledge with the mention of one resource that could be used to check the explanation

2 Answer contains one explanation showing a sketchy knowledge base with reference to a minor resource such as a science book

1 Answer is missing or misinformed

Some Instructional Influences on Student Thinking in Classrooms

Charles Fisher
and
Alice Horton
University of Northern Colorado

Draft document - not for citation

June 15, 1992

Introduction

It is unlikely that there ever was a time when educators did not dispute the purposes of schooling. In America, the debate has been framed by themes like learning of basic skills, fostering participation in a democratic society, transmitting cultural literacy, and preparing people for the workplace, among others. One manifestation of the debate, and one that has engaged literally thousands of educators in the past ten or twenty years, is an increasing focus on teaching thinking skills. From this point of view, a high priority for schooling is to increase the facility with which students use symbol systems to represent and deal with various classes of phenomena. That is, schools should not only teach students specific content but also should develop students' thinking skills.

The term thinking skills is used here to refer to a relatively broad array of learned activities. The general domain can be inferred from a few of the distinctions that have become commonplace in education. For example, educators often contrast basic with higher-order skills. Since the publication in 1956, of what has become known as Bloom's Taxonomy, many people think of higher-order skills as being associated with the upper levels of this hierarchy. Another common distinction is that between acquisition of factual knowledge, on the one hand, and problem solving and problem framing, on the other. For some time now, psychologists have been portraying differences between cognition and metacognition where metacognition refers to executive control of basic cognitive processes. From these distinctions, and many others in common use, thinking skills refer to the general and specific cognitive processing activities used in identifying, storing, retrieving, interrelating, and making meaning from sensory and symbolic data.

To a great extent, the extraordinary rate at which human knowledge is increasing has been the impetus for attention to thinking skills. Since much of what is known, especially in the scientific domain, changes radically during one's lifetime, schools must prepare people to continually learn and relearn. The need to keep one's knowledge current has placed a premium on the processes of thinking themselves. With this in mind, the emergence of cognitive psychology during the last few decades is hardly a coincidence. In fact, there is a strong correlation between increasing interest in thinking skills and the development of cognitive psychology.

By the 1980's, many schools and school districts included in their mission statements an intention to improve the thinking skills of their students and specific programs were designed to carry out this intention. Sometimes thinking skills were treated as a separate curriculum strand with time set aside for instruction in thinking skills *per se*. In these cases, there was often little change in the way that instruction was implemented. That is, thinking skills were treated as another content to be taught, and students were expected to know about these skills in addition to other curricular offerings. In some instances, instruction on thinking skills was intended to be integrated with the content or discipline being taught. In these latter cases, successful implementation would require more than superficial changes in fundamental aspects of instruction. Educators envisioned classrooms where students were actively engaged in challenging tasks, striving to invent or apply useful cognitive strategies, reflecting on both what they had accomplished and how they had accomplished it, and mastering in the process both content knowledge and thinking skills.

One prominent example of this latter genre is entitled the Dimensions of Learning [Marzano, 1991 #22]. When programs of this type are introduced in elementary school classrooms, what changes in the intellectual or thinking environment occur? What new cognitive demands are made on students and teachers and what shifts in emphasis on particular kinds of student and teacher thinking come about? These questions provide a general frame for the current study. Teachers in two of the four classrooms in which the study was conducted had had extensive training in the Dimensions of Learning model.

<u>The Dimensions of Learning</u>. The Dimensions of Learning Program [Marzano, 1991 #22; Marzano, 1990 #8; Marzano, 1989 #10; Marzano, 1988 #9] is a conceptual framework and training program for K-12 educators that is designed for use in planning and implementing classroom instruction with a strong focus on content integrated with thinking and learning skills. The Program was created after an extensive review and integration of work on teaching, learning, decision making, thinking, creativity, and cognition. The Program is organized around five "dimensions:" (1) positive attitudes and perceptions about learning; (2) acquisition and integration of knowledge; (3) extension and refinement of knowledge; (4) meaningful use of knowledge; and (5) productive habits of mind. The dimensions are briefly summarized by the program developers in Appendix A (see <u>Dimensions of learning: Teacher's manual</u> for details of the Program's content [Marzano, 1991 #22]).

Problem statement. When teachers have had extensive training in Dimensions of Learning, do classroom processes reflect higher amounts and levels of student thinking? Do the classroom activities that students engage in offer greater opportunity for learning content *and* thinking skills? How do students' experiences differ from those of students in similar classes where no teacher training on Dimensions of Learning occurred?

The primary goal of this study is to examine the kinds and amounts of thinking that students engage in during classroom instruction. While thinking cannot be examined directly, several kinds of evidence are assumed to be associated with particular kinds of cognitive activity. In this study, indirect evidence for student thinking is sought in two domains. First, what kinds of tasks do students engage in during instruction? Second, what characterizes students' and teachers' talk as students work on instructional tasks? Since classroom tasks constitute the immediate context in which teacher and student talk occur, these two domains are not entirely distinct. However, they each provide practical perspectives on opportunities for students to think and act during classroom instruction.

The study classrooms. The study describes teaching and learning activities in four elementary school classrooms in a suburban district near a large western city. Two of the teachers, Ms. Landis (grade 4) and Ms. Candel (grade 5), taught at Jackson Elementary and had been working with the Dimensions of Learning Program for three years when the data were collected in spring 1991. These two teachers had worked with early as well as revised versions of the Program and had been coached by several of the Program developers. Both teachers had more than ten years teaching experience and were highly regarded by their peers. Because of their extensive training in Dimensions of Learning and classroom experience in implementing the Program, they were considered to be exemplary practitioners of the Program. The two remaining teachers who participated in the study, Ms. Markfield (grade 5) and Ms. Stanford (grade 5), taught at a nearby school that served comparable students within the same district. These teachers were also experienced and highly regarded by their peers. While each had participated in a wide variety of inservice training events, some of which dealt with aspects of thinking skills, neither had had training in the Dimensions of Learning Program.

Collection of classroom process data. Classroom process information was collected during four consecutive science lessons in each grade 5 class and in Colorado history in the grade 4 class. Each of the approximately one-hour lessons was videotaped and observation fieldnotes were also recorded. In all but two lessons, a second audio track was obtained from a small cassette recorder placed on a student's desk. The tapes and notes were collected during the second week in March 1991 in one school and during the third week in March in the second school. An audio track was transcribed for each lesson. The video tapes and transcriptions of classroom talk constituted the data for the study.

Task structures. Two main interpretative frameworks were used during data analysis. The first draws on the idea of a schoolwork task [Blumenfeld, 1987 #2; Doyle, 1983 #1; Fisher, 1990 #3; Hiebert, in press #27]. From this point of view, students encounter schoolwork as a series of academic tasks and the structure of the tasks influences the kinds and amounts of participation that are available to students. Using the task framework, each lesson was segmented into activities or subtasks and eight aspects of each activity were recorded (task coding procedures are described in Appendix B). In this study, we are trying to identify the kinds of thinking that classroom instruction "pulls for" students to engage in. The characteristics of activities that were initially considered to be relevant to the study goals included: activity purpose, duration, function, format, product type, product specification, and complexity. These, and other characteristics of tasks, have been used in a variety of studies of elementary classroom instructional processes and student learning [Blumenfeld, 1988 #16; Fisher, 1990 #3; Fisher, 1991 #25; Mergendoller, 1988 #6].

Of the activity characteristics used in this study, activity purpose and duration require no further description. Activity function refers to whether the activity is primarily being done in advance of student work (labeled prework activities); students actually engaging in the work itself (labeled work activities); or students reflecting on or reconstructing meaning from work already completed (labeled completion activities). Activity function distinguishes activities where students are *doing* the work from getting ready to do it (prework) and reconsidering the work after the fact (completion).

Activity format describes the general distribution of classroom talk and social organization for learning. Although activity format categories were identified from the videotapes, later analysis focused on only three categories; teacher-led talk, student-led talk, and everything else aggregated into a miscellaneous category.

Activity product is a short verbal description of any *concrete* product that is expected to be produced during the activity. Activity product type distinguishes among activities where individual students produce products, products are produced by groups of students, and activities that have no concrete products.

Product specification is a rating (from 1 to 5) of the direct influence students have had on determining the form and function of the product. Activity complexity refers to the number and kinds of cognitive actions generally required by an activity. In this study, activity complexity was measured by classifying activities according to the six levels of Bloom's taxonomy. Subsequently, complexity was reported in three categories (low, medium, and high) by collapsing knowledge and comprehension, application and analysis, and synthesis and evaluation respectively.

Talk structures. The second framework draws on distinctions in what students and teachers say to one another during instruction and in how and when they say it [Hiebert, 1991 #23; Hiebert, in press #27]. Typed transcripts[1] from the video and/or audio tapes were used for this analysis.

Before examining the transcripts, four aspects of classroom talk were selected for analysis. First, we examined the amount of talk generated by teachers and students. We also looked for repeated patterns of turn-taking in the transcripts. Second, we identified student turns that were longer than a word or phrase. We looked for occasions when students publicly: (a) elaborated or extended ideas; (b) provided explanations for events or relationships; and (c) gave an interpretation to the actions in the lesson. We were especially interested in student opportunities to construct or reconstruct meaning from the lesson by participation in classroom conversation. Third, we identified examples of teacher talk that focused directly on learning processes. We wanted to know if teachers made explicit references to metacognition, strategies for learning the content, or coaching on thinking. Fourth, we examined the overall frequency and kinds of questions that occurred in classroom talk. We examined the levels of complexity of questions, whether the questions were asked by teachers or students, whether single or multiple answers were encouraged, and whether patterns could be identified over series of questions. We also looked at responses to questions, who responded, the length and depth of the responses, and the length of time that questions remained open or "unanswered."

As the videotapes were viewed and reviewed and the transcripts were read and reread, several additional themes arose. These themes and examples of

[1] The transcripts provide a very complete record of teacher talk and a good representation of student talk during whole class activities. However, when several teams of students are working or when students are working independently, the transcripts are less than complete. Stated in a slightly different way, the transcripts are essentially complete records of classroom talk when one person is speaking at a time but very incomplete records when several persons are speaking simultaneously. In addition, since the teachers' voices are much stronger than their 10 to 12 year-old students' voices, the transcripts are generally more complete for teachers than for students.

classroom talk that gave rise to them are included in the following descriptions of the four classes. Each of the classes is described in turn followed by comments that cut across classes.

Colorado History in Ms. Landis' Class

Classroom setting. Ms. Landis worked with 22 students in a self-contained fourth-grade classroom. Individual student's desks were grouped in five face-to-face clusters around the room. Three of the clusters had four desks each and the remaining two clusters had five desks. Ms. Landis' desk, a bookshelf and a study carrel (presumably for students) filled one corner. A countertop (with cabinets below) covered about half of one side wall; there were three bookcases and two chalkboards in the room. The single door to the room was at one end of the rear wall. Beside the door, a high coat rack jutted into the room for about eight feet cutting off eye contact with anyone who might pass by in the corridor. Although the room had no outside walls and therefore no windows, it was pleasant enough and well-organized for instruction.

One wall displayed examples of students' work in history and nearby there was a poster describing the "habits of mind" that constitute one of the Dimensions of Learning. Each student had three cards taped to his or her desk giving overviews of self-regulated learning, critical thinking, and creative thinking, respectively. The information on the cards is also part of the Dimensions of Learning framework.

For the study, we observed four consecutive social science lessons. The lessons took place from approximately 9:30 AM to 10:20 AM and focused on Colorado history. Apparently, students had examined several aspects of Colorado history relating to the indigenous peoples, various waves of European settlers, development of economic activities like mining, farming, and ranching, and entry of Colorado into the United States.

In the lessons that we observed, students were undertaking experimental inquiries into: why current inhabitants who were not born in Colorado had moved to the state; why many states required public schools to allocate relatively large amounts of instruction to that State's history; and how much adult native-born Coloradans knew about Colorado history.

Brief description of a lesson. Here is how the third lesson that we observed played out. In earlier lessons, students set out to find out why people who are currently living in Colorado but who were not born in Colorado, moved to the State. They had generated several "maybe becauses" and had developed a questionnaire based on these possible reasons. In the days just prior to today's lesson, students had taken copies of their questionnaire home and interviewed about four adults each. This 45-minute lesson was parsed into nine activities. The boxed paragraphs that follow

(Figure 1) represent the activities in the order they occurred. For each activity, a descriptive title, a synopsis, the activity function (prework, work, or completion) and duration (in minutes) are listed.

Figure 1: Outline of Activities in Lesson 3 from Ms. Landis' class.

Activity A: Directions for compiling the questionnaire responses. Students are to work in teams (as usual, the clusters of desks define five cooperative learning teams). Ms. Landis will ask about a questionnaire item and each team will tally their responses for that item. A reporter from each team will relay the information to Ms. Landis who will record the information on newsprint. Students are guided through a fictitious example or two. This procedure will be repeated for the other items except that students within a team are to take turns being the reporter. (These prework directions took 3:51).

Activity B: Questionnaire data are aggregated to the class level. Ms. Landis begins by asking "How many interviews did you do in your teams?" Each team confers, arrives at a total and tells Ms. Landis. Each team writes down the number of interviews done by the other teams and carries out the addition to get the class total. Fifty-nine interviews have been conducted. Using this sequence, - teacher reads an item, student teams come up with team total, reporters share team total with teacher and whole class, all students calculate the class total - the class compiles numbers of respondents who "choose" to come to Colorado, who "had to" come and the various reasons underlying their actions. (This work session took 16:51).

Activity C: Rearranging materials. During Activity B, Ms. Landis recorded the class information on a large piece of newsprint that was taped to the chalkboard. Having completed the aggregation of data, there is a short break as Ms. Landis, with the help of two students, unsticks the newsprint and places it very high on the front wall of the classroom so all students can see it easily. (This management activity took 2:38).

Activity D: Analyzing and drawing conclusions from the data. Ms. Landis asks students about the meaning of the data. She leads a discussion that has students examine and respond to the frequencies of particular responses and the generality of the data given that 59 people were interviewed. She has students speak about what was surprising to them in the data and finally has students weigh the "maybe becauses" that they started with, against the data. (This completion activity took 9:27).

Activity E: Collection of students' survey forms. A student is directed to collect the surveys. (This management activity took 0:43).

Activity F: Introduction of inquiry into why each state teaches state history. Ms. Landis notes that class is spending about 10 weeks on Colorado history and points out that other states spend about that amount of time on their state histories. She then asks the students why state history is treated this way. Students are asked to write down "I wonder why most states require state history in such large amounts?" This represents the first step in the experimental inquiry procedure. Ms. Landis then directs students to spend a few minutes individually writing down some "maybe becauses" that could conceivably explain the situation. (This prework activity took 7:36).

Activity G: Students generate individual lists of "maybe becauses." Students work quietly as they generate a lists of possibilities to respond to the question. There is emphasis here on generating more than one possibility. (This work activity took 2:13).

Activity H: Share "maybe becauses" within teams. Students tell each other one or more of the "maybe becauses" from their lists and look for "common" possibilities. (This completion activity took 0:47).

Activity I: Groups share "maybe becauses" with the class. Ms. Landis asks students to raise their hands if at least two students had similar ideas on their lists. One person from each team states one "maybe because" to the class. (This completion activity took 1:32).

Task and talk structures in the lessons. While there was variation from lesson to lesson in the task and talk structures in Ms. Landis' class, this lesson illustrates the kinds and amounts of interactions that characterized the instruction that was observed in the class. Students often operated in five cooperative learning teams defined by the clusters of desks. In Activities B and D, for example, Ms. Landis spoke to the class as a whole for a brief period, them had students talk to each other in their cooperative groups for a brief time and then, with Ms. Landis' guidance, representatives from each cooperative group shared information with the whole class. This sequence, teacher-led whole class discussion, small group student-led discussion, whole class sharing by small group representatives, was repeated approximately six times in rapid succession during these two activities. This particular structure encouraged students to speak often and their talk was directed alternatively to other students in their team and everyone in the class. This pattern is strikingly different from the traditional triad of teacher question, individual student response, teacher evaluation that dominates classroom discourse in many schools [Cazden, 1986 #24].

To illustrate some characteristics of talk in this classroom, consider a portion of the transcript taken from Activity D (see Figure 2). At this point, the class has completed compiling their interview data and Ms. Landis is guiding them in making sense of it. The class has already considered "the first half" of the data and are moving on to the "second half."

Figure 2: Classroom talk excerpted from Activity D, Lesson 3.

T: O.K., now let's look at the other half. Let's look at the "had to's". Right up here. Find the things you talked about. The people who said they "had to" come here. Can you remember?

S1: Most people came here because of job transfers.

T: O.K. The largest number was "jobs," the highest number "jobs," job transfers. And, what else would you say about that half of the survey? Kelsey.

S2: The lowest number of people was the "health reason."

T: The lowest number of people was the health reason. I don't know if you recall but recently in one of the film strips we saw, they talked about people coming to Colorado sometimes

because they had severe asthma trouble. They were
recommended to come out here.

S3: That's why my Mom came here.

T: I had friends from New York state who's whole family came
out here because their son was having asthma trouble.
Ah, but again, we're basing this simply on what group of
people?

S: (several overlapping responses)

T: The people we talked with. OK, if we could interview again
with different people, might some of these things change?

S: (several "yes's")

T: Might some of these stay about the same pattern?

S: (several "yes's" and "yeah's")

T: So when you are drawing conclusions you need to be careful
about what you are saying. OK. But do you think we can say over
the group we interviewed that more came because they
"wanted to"?

S: (several "yes's" and "yeah's")

T: Did anyone have a prediction, an individual prediction, of the
big reason that they came - because they "wanted to" or they
"had to"? Did it turn out the way you predicted or not? Denny?

S4: Well, that, I thought that, maybe that "It's a beautiful state",
I thought that, I predicted that that would be like maybe the
third highest thing . . . that because it's got good ... great views
and stuff but it turns out that its four people.

T: O.K. Thank you very much for sharing that. Any last
comments, thoughts or opinions and then we'll move on to the
other part of our long-term task that's coming up next.
Andrea?

S5: Well, I thought there was going to be more health reasons.

T: You thought more health reasons would come up. OK, Jordan.

S6: Well, I thought there was gonna to be a lot more job
opportunities.

T: For people.

S6: Yeah.

T: OK, and Adrian

S7: I thought that like the "had to" would be like the "had to" wouldn't be so low and the "wanted to" wouldn't be so high.

T: You thought they might be more balanced? Not necessarily equal but closer together. O.K. Thanks for sharing that. Mr. Beale?

S8: I thought that the "had to," there was a lot more "others" because of ...

T: Oh! You thought this (pointing) would be higher? Because why? What was your thinking?

S8: Well, most people that move here "had to" because of that. I had some friends, I forgot why they "had to," but it wasn't one of those.

T: So, on your individual surveys, this was the bigger reason than other reasons.

S8: I didn't survey those people, I didn't have any "others".

T: Oh, O.K.

S8: But I just thought there would be "others."

T: O.K. Can I send Jonathan around to pick up the surveys for me.

......

This section of classroom talk illustrates teacher and students speaking alternatively, a structure that is very common in classrooms. However, the talk does not conform to the recitation format. In this example, students talk often and their utterances are extended beyond one- or two-word answers. In the three and one half minutes represented by this example, at least eight different students (20 percent of the class) spoke. The questions that students are responding to are often open ended and relatively complex (see, for example, lines 7-8, 18, 21-22, 27-29). For most of these questions, students have to comprehend the data on the newsprint at the front of the room, understand how the data were collected, and generate an appropriate response.

Notice that in this discussion, Ms. Landis does not evaluate students responses very often. Quite often, she repeats literally what students have said (see lines 10, 43, 51) or explicitly acknowledges students' contributions to the discussion (see lines 38, 52). In this way, Ms. Landis takes a role that facilitates the discussion; students seem to participate readily, appear to take risks, and reveal their ideas as they are being formed. Look, for example, at S4's statement (lines 34-37). You can almost hear the student struggling to make sense here. His statement has several stops and starts, however, it is quite clear that the student is "respecting the data." Because only 4 of the "wanted to's" gave "It's a beautiful state" as their reason, the student is apparently willing to question his earlier prediction. This presumably represents quite sophisticated reasoning on his part. In a manner of speaking, the student is thinking out loud. Ms. Landis acknowledges the student's contribution (line 38), she does not evaluate it.

Ms. Landis then signals that it's time to move on unless other students want to share their thoughts or comments (lines 38-40). Several students take advantage of this opportunity to say what they have been thinking about the data (lines 42, 44-45, 54-55, 58-60, 63, 65). In most cases, Ms. Landis repeats (line 43) or rewords (lines 51-52) students' comments.

In the last case (lines 53-65), there are seven turns in the exchange. In this exchange, it is not clear what the student has in mind. Ms. Landis begins by encouraging the student to expand his explanation (lines 56-57) by saying "Because why? What was your thinking?" The student does go on to explain (lines 58-60) and the teacher attempts an interpretation (lines 61-61). This interpretation apparently does not fit from the student's point of view (line 63) and the teacher does not press any further (line 64). Although the student still wants to communicate his thought (line 65), Ms. Landis acknowledges him with an OK (line 66) and signals that the activity is now over and the class is about to move on (line 66).

A major characteristic of the classroom learning environment, one that can be found throughout the transcripts of Ms. Landis' history class, is illustrated in this piece of dialogue. The relationship that Ms. Landis has established with her students is, to a great extent, communicated and maintained through her enactment of a particular role. While her role varies in different situations, I want to focus attention briefly on her facilitation of classroom conversation. She establishes the purpose of the conversation (see Figure 3) early in the activity from which the example is taken. Ms. Landis says:

Figure 3: Classroom talk excerpted from Activity C, Lesson 3.

T: Now we are going to discuss the whole big picture and see if you can draw any conclusions. ... All right. What would you do comparing the top half to the bottom half - "wanted to" to "had to?" Remember we had all those "maybe becauses" and we said, well, it seemed to fall into two groups - the "choices" and the "had to's." What conclusions could we draw about that? .... What did your group think? .... What could we say about that?

Throughout the ensuing conversation (see Figure 3), she "facilitates," that is, she takes responsibility for keeping the conversation going, for having several students contribute, for legitimizing students' contributions, and encouraging students to "think-out-loud."

What is also important here, though sometimes more difficult to see, is what the teacher does not do. In particular, she does not evaluate the students' responses, and she does not appear to have "a right answer" in mind. To the students, Ms. Landis could appear to be more interested in their thinking, in their views about what the data mean, than in an answer that exists outside of, or existed before this conversation unfolded.

Ms. Landis intervenes on the conversational process but does not intervene on the content (in this case, the substance of the conclusions to be drawn from the questionnaire data). Since content and process are not entirely independent, it may be more accurate or useful to say that Ms. Landis is relatively interventionist on the process of the conversation and relatively laissez-faire on the content. With this in mind, let's reexamine the interaction between Ms. Landis and S8 (lines 53-66). S8's initial contribution to the conversation is difficult to understand (lines 54-55). Ms. Landis tries to draw him out in a non evaluative manner (lines 56-57) and S8's second statement is also somewhat difficult to comprehend (lines 58-60). Ms. Landis tries again (lines 61-62) but with S8's third turn (line 63), the interaction still seems to be unclear (from Landis' point of view). By now, Landis' guidelines are beginning to conflict. That is, how can she continue to facilitate or support S8's participation in the conversation without becoming more evaluative? If she "stays with" S8 much longer, will she inadvertently make him appear to be incompetent to participate in the conversation and thereby demonstrate for the other students one of the big risks in participating in this sort of conversation? In this case, the teacher "backs off" (lines 64 and 66) even though the student wants to continue to make his point (line 65). Ms. Landis closes the discussion here and moves on (line 66). This whole segment of the conversation (lines 1-66) has been quite successful in getting students to share their thinking about the data in the form of a sustained conversation. Apparently Ms. Landis judged that it was not appropriate to jeopardize this success by risking more time with S8 or by choosing a new student speaker.

Management of the tension between facilitating conversation in the classroom and evaluating various aspects of student behavior (verbal and nonverbal) is an ongoing dilemma in teaching. To a considerable extent, the quality of classroom conversation, the kinds of thinking that may be overtly practiced, and the particular students who participate competently in classroom conversations will be influenced by the teacher's strategy for handling this tension. Establishing and maintaining the kind of conversation in the example requires considerable sophistication on the part of the teacher.

In addition to the teacher's skill in managing conversations, the quality of classroom interaction may depend on the learning task. In the example we have been focusing on, note that the task has engaged students at several levels. They designed a questionnaire and interviewed adults in their community before trying to interpret the data. These questionnaire responses presumably have more meaning to the students than would be the case for data from an archive or textbook. Many of the students personally will have moved to Colorado and, therefore, interviewing of parents and neighbors is likely to relate directly to students' prior experiences. In this sense, the task is authentic and student learning is situated in a meaningful context.

Given this description and interpretation of classroom talk in Ms. Landis' history class, what function could it serve in terms of student learning? If students often participate in conversations like the one in the example, and if the teacher lets the learning task "carry" most of the content while she attends to facilitating classroom conversations, what kinds of cognitive activities are students likely to engage in? Because the teacher is relatively "quiet" on the content (the conclusions to be drawn from the questionnaire data), students presumably try to make sense of the data. They look at the frequencies for the subcategories and compare them with each other. This would appear to be the case, since students often talked about "more" and "less" (lines 5, 9, 36, 42). Students reason about whether or not the data are consistent with their earlier predictions (see student statements in lines 34-37, 42, 46, 49-50). Students formulate speech to express their thinking about the data. In short, students have a primary role in interpreting the data. They, or at least those who participated in the conversation, struggled to make some meaningful statement about the propositions and the empirical data. They could listen to other students and try to comprehend other students' statements or integrate them with their own.

The fact that Ms. Landis does not interpret the data for the students may be an important contributor to the kind of thinking that students get to do in this type of conversation. If Ms. Landis had interpreted the data, the cognitive experience for students would likely be radically different. In that case, students would have been presented with well-formed "answers" and presumably would have silently: (a) tried to resolve any discrepancies between their prior ideas about the data and the teacher's conclusions, (b) simply adopted the teacher's conclusions without addressing possible conflicts with their own ideas, or (c) rejected the teacher's conclusions out of hand. Alternative (a) puts a high demand on the student, because the student must do all the cognitive work to get the "presented conclusions" to fit into his or her representation of the situation without benefit of any external support and without the benefit of spoken language (the very supports that the conversation in the example is intended to provide). Even if the student accomplishes this task, the student will have "matched" or "aligned" his or her knowledge to, what may appear to the student as, an external reality and, therefore, miss the point that any conclusion from the data rests entirely on a set of agreements among human beings.

In alternative (b), the student may try to remember the "presented conclusion" on top of, or in spite of, potential conflicts with his or her prior knowledge. If such conflicts are not resolved, it is unlikely that the student will remember the conclusion for long let alone gain incite into how such conclusions are drawn. In alternative (c) it is unlikely that any change in the student's representation of the domain would take place. If a teacher habitually does the interpretative work in classroom talk, then there is a tendency for the specific interpretations that the teacher makes to take precedence over the process of interpretation itself. That is, students get a lot of factual information but are left on their own to master the intricacies of thinking and learning. It is not that one cannot learn to think under these circumstances, it's just that the instruction provides little or no access to these thinking and learning processes. To many students who come to hold knowledge to be something that exists separately from human beings, learning may often seem analogous to being "handed a brick", and consequently, tools of cognition simply do not exist.

Summary. Ms. Landis is portrayed as intervening on the conversational process and not intervening on the specific content of the lesson (except through design of the learning tasks themselves). We have examined in some detail a few of the ways in which Ms. Landis carries out this strategy through classroom talk and tasks. The effect of this strategy is to allow students to struggle overtly with making sense of the action in the class, to interpret the action through language with Ms. Landis taking major responsibility for maintaining and facilitating the conversation. In fact, in a number of ways, Ms. Landis acts like a metacognitive coach for students. The kinds of questions she asks are the very questions that students would be encouraged to gradually internalize. For example, she keeps track of whether or not the conversation is "relevant" and intervenes if it is not; she keeps track of time and generally determines when an activity change is to occur; and she asks if resources, that are not present, could be useful. These are the very kinds of monitoring functions, that once internalized and initiated by students themselves, would be referred to as metacognition or self-regulation.

When the four lessons that were observed in Ms. Landis' history class are examined, there were many explicit references to specific aspects of thinking processes and to specific material included in the Dimensions of Learning framework.

Science in Ms. Candel's class: The human circulatory and respiratory systems

Classroom setting. Ms. Candel worked with 24 fifth-grade students in a semi self-contained classroom. The classroom had three full walls; the front wall had a large chalkboard and a screen for displaying overheads; the rear wall had a counter top with cabinets below for about two-thirds of its length; and one side wall had windows for about one-half of its length. The fourth wall - the other side wall - went floor-to-ceiling from the back of the classroom but stopped short of the front wall by about 10 feet. This fourth wall separated Ms. Candel's classroom from an adjacent classroom. These two rooms shared one doorway to the hallway and had a common entrance area where the foreshortened side wall was "missing." Along the short side wall immediately adjacent to the opening, there were three computer stations, that were used as needed by Ms. Candel's class as well as by students in other classes. Next to the computers, a series of low bookcases jutted out into the room making a, more or less, square area in the back corner of the classroom that contained the teacher's desk. During the observed lessons, this back corner and the teacher's desk were very infrequently used. The remainder of the classroom contained individual student desks that were clustered into 6 face-to-face groups. There were three groups of four desks, two groups of five desks, and one group of six desks, making 28 in all. During the observations there were never more than 24 students in the classroom. The room was bright, comfortable and had the feel of a well-used relaxed workspace.

As in Ms. Landis' room, there was a poster of "habits of mind" on one wall and well-worn cards outlining self-regulation, critical thinking, and creative thinking on each student's desk. Four consecutive science lessons were observed for the study. The lessons began and ended at approximately 1:30 PM and 2:15 PM respectively.

The class had been studying human biological systems. Early in the sequence of observed lessons, the class was working on the circulatory system. Teams of students designed, performed, and explained simulations of the circulatory system. The whole class, guided by Ms. Candel, acted out and later discussed the meaning of a major portion of the circulatory system. At this point, the class moved on to study the respiratory system. They began by working in teams, defined by the clusters of desks, to list knowledge that they already had about the respiratory system. Items from these lists were shared with the whole class and, using an overhead, Ms. Candel recorded the information. At the beginning of the third observed lesson, students worked in teams to generate lists of things they wanted to learn about the respiratory system. These questions were shared in the whole class and then students read assigned material from a textbook. Reading was first done silently and later, aloud, in teams.

Brief description of a lesson. Here is how the fourth lesson that we observed played out. This 56-minute lesson was parsed into thirteen activities. The boxed paragraphs that follow (see Figure 4) represent the activities in the order they occurred. For each activity, a descriptive title, a synopsis, the activity function (prework, work, or completion) and duration (in minutes) are listed.

Figure 4: Outline of Activities in Lesson 4 from Ms. Candel's class.

Activity A: Today's task and its context. Class is to use the KWL framework to support learning about the human respiratory system. Students, working in teams, are to complete the reading of 7 textbook pages (if that was not completed in the last lesson); check to see if their questions (from KWL framework) were answered; and then write "what I learned." (These prework directions took 3:26).

Activity B: Student teams work on acquiring knowledge from text. Using the KWL procedure, teams of students work on answering their questions about the respiratory system from the text. (This work session took 13:19).

Activity C: The learning task is amended. In a brief interruption of Activity B, teacher asks students, in teams, to make a list of 10 things learned about the respiratory system. Ms. Candel also tells students that the new folders that she just handed out are to help students keep materials about the respiratory and circulatory systems in one place. (This prework activity took 0:55).

Activity D: Students writing "what they learned" in teams. Same as Activity B except that teacher has added more specification to the work (see Activity C). (This work activity took 2:50).

some classes, it seems that students realize that if they wait long enough, the teacher is almost certain to provide an answer. Ms.. Candel appears to be quite another kind of teacher.

Summary. In Ms. Candel's class, students spent substantial amounts of time reconsidering what they had done during "work" sessions and generating statements about the meaning of their actions (especially during simulations and whole class sharing sessions). Relatively speaking, Ms.Candel did not talk very much in class. She used the academic task and materials to provide students with access to the content of the unit and did not present the material herself. Like Ms. Landis, Ms. Candel did not intervene on the content often but facilitated conversations on the classroom and coached students on ways to go about accomplishing their work. During whole group sharing activities, Ms. Candel regularly recorded student ideas and comments on an overhead, thereby keeping a record in front of students and creating an artifact of the discussion that could be referred at a later time.

Activity E: Ms. Candel sets up whole class sharing of knowledge learned about the respiratory system. Students are directed to work as a whole class. Students are to share examples of information that they have learned from the text. (This prework activity took 0:51).

Activity F: Whole class sharing of knowledge learned about the respiratory system. Students identify examples of new knowledge. Ms. Candel records items using overhead. Students add items to their individual lists as appropriate. (This completion activity took 8:16).

Activity G: Elicit and discuss the (previously introduced) steps of experimental inquiry. Ms. Candel leads whole class discussion in which students recall the structure of experimental inquiry. Teacher then turns to eliciting reasons why the steps might be useful. (This work activity took 6:56).

Activity H: Ms. Candel sets up application of experimental inquiry. Ms. Candel directs students to come up with a question that is a candidate for an experimental inquiry. The question could be one from their KWL lists that was not answered in the text material. The question must be one that they actually wondered about and discussed in their teams. (This prework activity took 0:49).

Activity I: Students, in teams, develop authentic "I wonder why's." (This work activity took 4:28).

Activity J: Ms. Candel sets whole group task: Sharing of "I wonder why's." (This prework activity took 0:42).

Activity K: Whole group sharing of "I wonder why's." Ms. Candel leads whole class discussion in which students describe a question for inquiry. Teacher records students' questions on an overhead. For each question, students suggest a possible reason. (This completion activity took 11:02).

Activity L: Ms. Candel sets up team work activity to generate tests for each of the "maybe becauses." (This prework activity took 1:02).

Activity M: Students, in teams, prepare to develop testable experimental inquiries. Students write down the steps in experimental inquiry and record homework assignment - to generate all steps for an experimental inquiry to address their "I wonder why" that was identified in class. (This prework activity took 1:44).

Task and talk structures in the lessons. This lesson illustrates several patterns in Ms. Candel's interaction with her students. Extensive use of cooperative learning teams resulted in students having repeated opportunities to discuss issues with other students. In conjunction with the cooperative teams, a typical sequence of activities began with a short presentation of directions or task set-up by Ms. Candel followed by students working in teams on the activity that, in turn, was followed by a whole class discussion in which students shared with the class the results of their immediately preceding groupwork. This pattern is an adaptation of the workshop class described in the Dimensions of Learning Framework.

This structure increased the amount of talk generated by students as noted earlier in comments about cooperative learning groups. In addition, the whole class sharing or debriefing session gave students a second chance to consider the ideas that were discussed in their small groups. For example, while working in his small group, a student might think that an idea or explanation presented by one of his teammates was a much better explanation for the phenomenon being discussed than his own initial view. The student might immediately adopt this explanation. But let's say that the explanation does not account for a critically important piece of data that for some reason was overlooked in the small group's discussion. When small group discussions were immediately followed by whole class sharing, there was another context in which to review, reconstruct, or reconsider the "interesting" ideas that were presented in the small groups.[2] At this point, there was another opportunity, a "second chance" for a student or the teacher to "see" the flaw in the idea and to comment on it. There was, of course, no guarantee that an idea would be improved in this second round of discussion, but there was a reasonable opportunity for "improvement" since, there were more participants in the second stage of the discussion (the whole class) and students had more time to think about

[2]Not all of the ideas presented in small groups will be re-presented in the whole class. Though we do not dwell on the point here, the selection process that determines which ideas get re-presented and which do not and who controls this process, is likely to characterize the intellectual quality of the ensuing classroom discussion.

the various ramifications that may have been relevant. Indeed, there was also the possibility that "good" ideas would be distorted or rejected in this process.

The quality of student thinking that was encouraged in Ms. Candel's classroom was directly influenced by the concatenation of these small group discussions and whole class sharing sessions. Participants in these discussions were prompted to process the relevant information more than once, they may even join the discussion by bidding for the floor and putting some aspect of the issue at hand into words. Whether an individual actually speaks or not, anyone who is attending to the conversation is drawn into a series of comparisons and judgments. "Oh, that's what Meredith thinks, let's see do I agree with that?" "There's a new possibility in what Terry is saying, does my current thinking account for that?" To the extent that the overt conversation arises with, coexists with, or encourages this kind of covert "conversation," we can say that students are being thoughtful. In Ms. Candel's class, it is as though the reasoning and judging processes are distributed fairly evenly among the students and occur over a longer time span than would be the case if these processes were being primarily carried out as they usually are, by the teacher.

But why can't the very same thoughtful processing occur among students when a teacher is lecturing or telling about complex relationships among concepts? There is no reason why it cannot and, in fact, it presumably does, but only for those students who have learned to operate in this way. If, in the extreme case that instruction consisted entirely of lecture, full responsibility for processing the information falls to the students, but without any mechanism for negotiating the pace and direction of the communication, many students choose to think about, or do something else. The two stage process in Ms. Candel's class distributed the cognitive burden across participants and therefore lessened the burden on individual students. As students engaged in discussion, they heard other students and the teacher asking questions that stimulated thinking that the student would be unlikely to do if those questions were not asked.

Questions and statements by other students (and the teacher) functioned in a manner similar to metacognition. When someone else generated questions and comments in cooperative groups and whole class sharing activities, there was less need for individual students to metacognize. Talk by other students approximated this function. However, in the hypothetical all-lecture situation, students must perform all of the metacognitive and self regulative functions themselves. In Ms.

Candel's example, metacognition and self-regulation are supported or complemented by the conversation itself.

For this latter support to be realized, the conversational process must be shaped. This shaping was done by the teacher. Hence the strategic intervention on conversational process but nonintervention on content that was characteristic of Ms. Candel's (and Ms. Landis's) class.

In addition, this conversational process - the successive refinement of ideas and concepts after repeated opportunities to express them and hear other's views on them - is analogous to the manner in which most academic communities proceed. For example, journal articles are published in an area and when a sufficient number of articles exist on a given topic, review articles are written. These reviews indicate a broader interest in the domain and usually try to make "new" sense of the domain and to relate it to "bigger" issues. In this way, participants in the domain continually negotiate the meaning to be attached to the various phenomena in the domain. Even determining which phenomena are "hot" in a domain at a particular point in time is negotiated in this manner.

Ms. Candel's class included several activity sequences in which students designed, performed and subsequently discussed simulations of human biological systems. These activities together with the patterns identified in Lesson 4, account for well over half of the observed instruction. Use of these patterns increased the number of opportunities students had to contribute actively to classroom conversations, which in turn provided students with increased influence on the content covered and pace of interaction.

One way in which classroom talk is shaped comes about through constraints imposed by the structure of the learning task. In Ms. Candel's class, there were several illustrations of classroom talk being shaped in this manner. For example, when students were acquiring knowledge about the respiratory system from the textbook (Lessons 2, 3 and 4), Ms. Candel directed them to use the KWL strategy (Ogle, 1986).

Students began the KWL strategy by writing down and, subsequently, sharing with the whole class, what they already knew about the respiratory system (end of Lesson 2). This step served as an activator of prior knowledge and made that knowledge explicit by virtue of its being written and therefore accessible to students (or teacher) at a later time.[3] In this case, KWL was being used in cooperative teams, and as a result, a portion of the metacognitive burden was externalized in the form of talk among team members and, therefore, distributed among members of the team (see p. XX for commentary on this process).

Students proceeded to the second step of the KWL strategy (beginning of Lesson 3) during which they generated and recorded questions about the respiratory system. Team questions were shared with the whole class and recorded by Ms. Candel. During both of these structurally parallel sequences, Ms. Candel established and maintained the activity structure but was relatively silent about either the substance of the students' prior knowledge or the identification of what students would like to know about the respiratory system. She intervened on the process but left the details of the content to the students and the curriculum materials.

Students read the text silently. Then they read it aloud, in teams, and tried to answer their questions. Here is an example of the talk among team members (see Figure 5).

Figure 5: Classroom talk excerpted from Activity B, Lesson 4.

1	S: O.K. We're done with that.
2	S: No kidding! O.K. Now let's do our KWL.
3	S: What I learned. What did we learn?
4	S: I like the lungs. They're made of spongy tissue.
5	S: We already did it?
6	S: We already did a couple while I was reading.
7	S: Bronchitis is a disease from the lungs.
8	S: O.K. We already know that.
9	S: O.K. What else.
10	S: Allergies. Ragweed is a plant that causes allergies.
11	S: Like what's my name. You need to stop complaining.

3 In addition, most students would be likely to learn something in the process, because their classmates provide information about the respiratory system that was not previously known to every member of the class.

12 S: See, she even made up half of an "I."

13 S: Where did I make up half of an "I?"

14 S: Off your last "L." It looks like half of an "I."

15 S: You talk stupid.

16 S: You do! You're the one that made it up.

17 S: Well look who's complaining now.

18 S: Why, am I complaining?

19 S: O.K. What else did I learn? Oh, the air sacs looks like a bunch of grapes

20 S: Are you going to write these down?

21 S: O.K. Take a look.

22 S: Yes, the air sacs look like grapes.

23 S: The lungs look different. The lungs are different.

24 S: Many allergies are from trees and flowers.

25 S: You can get allergies from ragweed. That's what I do.

26 S: The lungs are different from each other.

27 S: What was that one?

28 S: Were you listening?

29 S: No.

30 S: Oh, when you inhale, the ribs move up; when you exhale, the ribs move down.

31 S: When I breathe my stomach moves in and out.

32 S: O.K. I'm inhaling, I don't feel my ribs moving up.

In this example, there were four students working together. Although the students were studying the human respiratory system, they clearly distinguish the KWL strategy as a learning tool. A student referred to the strategy by name (line 2), presumably he was understood by the other students because they proceed to implement the strategy.

The students made statements to each other that drew attention to and shaped the task. For example, a student says, "What I learned." and then turned this into a question to the group, "What did we learn?" (see line 3). Other examples of this task monitoring or externalized metacognition occurred throughout the transcript (lines 8, 9, 19, and 20). There was also talk that was not relevant to the task (see lines 11-18) but a student brought the group back to the task after only a few seconds (lines 19, 20).

The students also discussed things about which they were unsure. The last three lines in the example illustrate the beginning of a conversation about the motion of the body during respiration. There seems to be a hint of skepticism (in line 32) as a student says "OK. I'm inhaling, I don't feel my ribs moving up." The teacher interrupted the group at this point, but it is quite possible that this conversation could have led to a difference of opinion and subsequently to observation of respiration with a new idea in mind. In this example of students talking in a cooperative group, it appears that the KWL strategy resulted in students asking questions and making statements to one another that supported thoughtful treatment of the content.

As students finished this task, Ms. Candel gave them some coaching about KWL (see Figure 6). She points out that the KWL strategy often results in learning some things even though no questions were asked about them (lines 1-3).

Figure 6: Classroom talk excerpted from Activity C, Lesson 4.

T: As you finish your answers to your questions on "What I've learned," also remember to include in there things you learned and maybe didn't ask questions about.

...

T: And after you're done writing what you've learned, then I would like at least 10 items that you've learned. That makes it harder. ... You can do that as a team.

Ms. Candel elaborated on the KWL strategy by providing information to students about this slightly more advanced idea. Her timing was appropriate since students could immediately apply this guideline to the preparation of their records of what they had learned. In fact, she may well have legitimized what students were already doing anyway! This "coaching" was another example of the teacher's intervention on process while being passive about the details of the content (at least as far as her classroom talk was concerned).

Ms. Candel then requested that students, in teams, identify at least ten things that they learned about the respiratory system (lines 4-6). This required that students do the cognitive work of reviewing and summarizing what they learned and to explicitly distinguish between what they knew at the beginning of the task and what they learned in the process of doing the task. This tended to keep responsibility for organizing and refining the content in the hands and minds of the students. This procedure was quite different from classes where the teacher takes full responsibility for summarizing and presenting the "important points" to the students. In this latter case, students must either remember the summarized points or quietly do the cognitive work to verify or independently regenerate the teacher's summary.

Later in the same lesson, Ms. Candel had students restate the steps in the experimental inquiry framework. Once this was accomplished, she led students into an interesting discussion (see Figure 7). Ms. Candel asked what the point of experimental inquiry is (lines 1-2). A student gave a response that appeared to be pragmatic (lines 3-6). The teacher kept the conversation going (line 7) and then Danny attempted to contribute (lines 8-12). Ms. Candel acknowledged one of Danny's points by restating it and then asked the main question again (lines 13-17). This time she pointed to a possible relationship between experimental inquiry and science (lines 16-17). The next student (lines 18-19) claimed the floor then made four false starts before blurting out, "Because there's stuff you don't know." This was the first response that Ms. Candel showed an interest in and she encouraged the student to say more by stretching out "Aaannnd?" The student did not respond right away so Ms. Candel reassured him again by saying (line 20), "You got the idea." She restated his comment and then asked the big question a third time (lines 21-22). The same student continued in a promising direction (line 23), and the conversation continued around the theme of testing things that you are not sure about.

In this sequence, Ms. Candel "stretched" the class considerably. She challenged students with a question that could be taken on more than one level. Several students struggled to contribute to the conversation, two with little success and at least one with a useful advance. This example presumably represented a high level of frustration for the students, yet they

Figure 7: Classroom talk excerpted from Activity G, Lesson 4.

T: Why do you think she went through all these steps? What's the
point? How can we possibly use this?

S: Like if you have a problem, like a math problem, you could do
that with your math terminal in the morning. If you have, like a
hard math problem, you can (inaudible) because you've worked
on it.

T: Oh, good idea! I like that. Danny.

S: Well we're gonna go to (new school name) next year and we
might use science; we might use science a lot. Like if we, if
we, if we are gonna (inaudible) or something and the (inaudible)
really blows on it and it just burns hotter, we could put it out
(inaudible) a match.

T: So you're telling me two things. You're telling me, one, that
next year you might have to use experimental inquiry in science
a lot so it would be important. My question for Danny and for
all of you is why? Why would it be important to use
experimental inquiry in science? Why bother? Tell us.

S: Well, because maybe it's because you have to Oh!
because there's stuff you don't know.

T: Aaannnd? You got the idea. O.K. There are things you don't
know. So what is it that an experimental inquiry can do for
you?

S: Try to find it out.

T: Yes

S: It will make it a lot easier for you.

T: I would think. Yes.

S: It helps a lot.

T: It helps. But how?

did not show signs of abandoning the task. Instead they struggled to make sense of the situation. It was also interesting to note that Ms. Candel did not provide an opinion on her own question, but left students with this very high level question to think about. In most classroom situations, an unanswered question is a rarity. In some classes, it seems that students realize that if they wait long enough, the teacher is almost certain to provide an answer. Ms.. Candel appears to be quite another kind of teacher.

Summary. In Ms. Candel's class, students spent substantial amounts of time reconsidering what they had done during "work" sessions and generating statements about the meaning of their actions (especially during simulations and whole class sharing sessions). Relatively speaking, Ms.Candel did not talk very much in class. She used the academic task and materials to provide students with access to the content of the unit and did not present the material herself. Like Ms. Landis, Ms. Candel did not intervene on the content often but facilitated conversations on the classroom and coached students on ways to go about accomplishing their work. During whole group sharing activities, Ms. Candel regularly recorded student ideas and comments on an overhead, thereby keeping a record in front of students and creating an artifact of the discussion that could be referred at a later time.

Science in Ms. Markfield's class: The human respiratory system

Classroom setting. Ms. Markfield worked with 25 fifth-grade students in a self-contained classroom. Individual student desks were clustered in five face-to-face groups of five desks each. There were windows at either end of the front wall of the classroom. In the middle of the front wall there was a large chalkboard. The floor area at the "front center" of the room was kept clear of desks. The whole class often gathered in this space, especially at the beginning of a lesson, and sat on the floor while Ms. Markfield led discussions or lectured. The teacher's desk was also at the front of the room but off to one side. There was a sink at the back of the classroom and extra chairs were stacked along one side wall. The other side wall covered about half of the side of the classroom from ceiling to floor. The remaining portion of this side wall toward the rear of the classroom, was open providing access to Ms. Markfield's and to another classroom nearby. Some sound from the other classroom could usually be heard in Ms. Markfield's room. There was a large mural of student-made kites on a portion of the front wall; and counters, cabinets, bookcases, and bulletin boards at convenient places on the other walls. During the observations, a tall mobile media cart with a television set and VCR was usually stationed at the front of the room.

Three of the lessons we observed took place in the morning (approximately 9:00 AM to 10:00 AM) and the fourth in the afternoon (approximately 2:00 PM to 3:00 PM). The lessons we observed constituted all of the unit on the respiratory system. The students had just completed study of five other human systems but not with Ms. Markfield. Students rotated among several teachers for science instruction.

In the first lesson, Ms. Markfield provided overviews of the unit and the lesson, had students measure their heart and breathing rates, presented information on the respiratory system in discussion format, and elicited questions from the class about the content. In the second lesson, students read about the respiratory system in cooperative learning groups, participated in a whole-class teacher-led review of the written material, viewed a film strip on the respiratory system, and were assigned homework on the names and locations of organs in the respiratory system. In the third lesson, Ms. Markfield had students locate parts of the respiratory system by placing labels on a classmate, led a discussion about the flow of oxygen in the system, had students place organs on a drawing of the human body, played a videotape on the respiratory system, led a whole-class role model of the respiratory system, and described a test to be taken by students during Lesson 4.

Brief description of a lesson. The fourth lesson in the sequence was 52 minutes long, The lesson was parsed into nine activities. The boxed paragraphs that follow (see Fifure 8) represent the activities in the order they occurred. For each activity, a descriptive title, a synopsis, the activity function (prework, work, or completion) and duration (in minutes) are listed.

Figure 8: Outline of Activities in Lesson 4 from Ms. Markfield's class.

Activity A: Ms. Markfield briefly outlines today's lesson. The lesson will examine diseases that commonly affect the respiratory system. Later in the lesson, there will be a test on the unit. Students are sitting on the floor at the front-center of the room. (These prework comments took 1:00).

Activity B: A resource book for the respiratory system. Ms. Markfield shows a book entitled Body Facts to students, shows pictures of organs, and discusses content. (This work session took 5:29).

Activity C: Relocate in the classroom. Students move from "floor" to their desks. (This management activity took 1:39).

Activity D: Introduce cooperative learning task on respiratory diseases. Ms. Markfield gives verbal directions for task. Information on five diseases is at classroom tables (one "disease" per table). One student from each team is to become an "expert" on one of the diseases and later each student communicates his or her information to the other members of the base group (Jigsaw). (These prework directions took 2:44).

Activity E: Acquiring information on diseases. Each student goes to his or her station and reads about and takes notes on a disease. (This work activity took 10:28).

Activity F: Share information on diseases with base group. (This work activity took 15:25).

Activity G: Directions for the test. (This prework activity took 1:14).

Activity H: Students take test on respiratory system unit. (This work activity took 13:15).

Activity I: Students hand in all assignments related to unit on respiratory system. (This management activity took 3:47).

Task and talk structures in the lessons. A variety of task structures were used in Ms. Markfield's class. During the observations, lessons usually began with students sitting on the floor at the front of the classroom. Ms. Markfield often gave information about content orally, but students also watched films and read about the respiratory system. Physical models were available in the classroom and students handled these frequently. Students also participated in a simulation of the system. Cooperative learning tasks were used twice during the unit.

Several characteristics of Ms. Markfield's class can be illustrated by examining examples of classroom talk (see Figure 9).

Figure 9: Classroom talk excerpted from Activity A, Lesson 1.

T: This is your fourth rotation. The fourth group so that you've moved down to the fourth of the systems, there are actually five, because you did two of them with Dr. Kahn. So, when we finish this, you will have a real good idea of how some of the systems interrelate, how they work together, what their purpose is, the things that we're going to be doing through this week, so that by Friday what I would really like you to know is how oxygen gets from outside the body, with the air outside the body, into your blood that gets in the cells. As a part of that, I want you each to know the different organs that the air goes through - the different tracts, so to speak, and how it's going to get from outside and exactly what it does and I want you to learn the terminology and part of those things you're going to be tested on Friday. We'll be doing some models, we're going to be looking at some models, trying some different ways to show you how these work. We're going to have a film strip one day, we're going to have a film one day. I think that this will probably be the easiest system for you because you've done the other systems. It's not the easiest one, if it's the first one you do, but it is the easiest one when you've done all the other stuff, particularly having done the circulatory system. I think it will make it easier to understand. It's kind of hard to pull them apart because they work together so much.

This excerpt illustrates the clarity and explicitness with which Ms. Markfield communicates to students what they are expected to know (lines 3-14). This kind of statement, at the very outset of the unit and restated several times throughout the lessons, presented a clear focus on specific knowledge of content that students were to acquire. During a summary in lesson 3, Ms. Markfield stated, "These are the five that are done in red. These are the five organs I want you to remember. The nose, the pharynx, the trachea, the bronchi, and the lungs." This clarity of focus on specific content knowledge was aligned with the unit evaluation procedures. Students were told that they would be tested and when they would be tested on this material (line 14). The test, which was mentioned at least once in each lesson, covered precisely what was described as content to be learned in lines 3-14.

One way that the content was presented involved participation in lecture/discussion sessions. Figure 10 presents an excerpt from the classroom talk taken from the middle section of a 32-minute lecture/discussion activity.

Figure 10: Classroom talk excerpted from Activity G, Lesson 1.

T: O.K. We're going to talk about what the air goes through. If this were a little molecule, you know when the guy was here last week and he was talking about molecules, the escape artists. He was talking to you guys about how the molecules got around, how the air got from, uh, we were trying to revive a plant, stuff like that. O.K. In this air that we breathe, the molecules, oxygen, we're talking about how the oxygen gets, from out here in the room, into my body, into the blood, and out the same way, how that process, how that works. Where does the air come in. We know this part of it. When you breathe in, there are two ways air can get into the body. Let's hear it. What's one, Maria?

S: Through your mouth.

T: It comes through your mouth. What's the other one? It comes through your nose. And isn't it neat the way you can control how that happens? Everybody breathe through your nose. Now switch and breathe through your mouth. Can you breath? Can you open your mouth and breathe through your nose? How do you control that?

S: You can put your tongue up here.

T: You can close off the back of your throat. O.K. So that the next place the air is going to go is through your nose or your mouth. The next place it goes is the back of your throat and there's a name for that. Do you know what it is? Do you know what it is?

S: The pharynx.

T: Yeah, the pharynx. O.K., your pharynx. When the doctor shines a light down your throat, he's looking at the back there, that's your pharynx. When this molecule of air that's out here comes through my nose and goes through the nasal passages and comes through my mouth, but it's going to go through, both of those connect, at the pharynx, at the back of my mouth. So now there's a little molecule of air, it's in my body, it's back in the pharynx. The interesting thing is, as it goes through my mouth, I probably don't warm and heat the air very well, I just breathe it straight in and it goes straight down to my lungs. If I breathe it through my nose, I have up in my nasal cavity, I have the lining of the mucous membrane and it will heat the air, it will clean the air, warm it up, filter out a lot of stuff that shouldn't be going on into my lungs.

In this example, Ms. Markfield presented content verbally, she told the class directly about the knowledge she expected them to acquire. The information was directly relevant to the objectives that were stated at the beginning of the unit and to the test that students would take in a few days time. Teacher talk accounted for almost all (97 percent) of the talk in this excerpt. Although students spoke (lines 13, 20, and 26), their statements contained a few words at most. It was as though the teacher used these occasional student contributions, not to elicit their thinking, but to establish and maintain attentiveness. This section of classroom talk might be characterized as a "punctuated" monologue where teacher's voice carried the content message.

The role taken by the teacher in this kind of activity was that of dispenser of information. Although students had access to information through several other channels in Ms. Markfield's class, she began the unit by presenting the information herself. While Ms. Markfield took this role, what were the primary tasks for the students? The students listened to the presentation and occasionally showed that they were engaged by giving short responses to questions that have specific correct "answers". Ms. Markfield did not ask any open-ended questions that might have elicited either a long response from a student or a student-initiated question that might have shifted the direction of the conversation. In this activity that kind of interaction would not have been appropriate. The students who have grasped the "rules for participation," understand this point and participated in accordance with the implicit agreement. In this structure, the time for student questions was at the end of the activity. One implication of this way of operating is that the content of the presentation remains relatively fixed. Because students options for acceptable participation preclude negotiation of the content, the information that is communicated can be controlled by the teacher. In these circumstances, students are likely to view knowledge as something that exists separately from them and is not so much recreated by them as handed over to them (like a baton in a relay race) by the teacher.

While listening to the presentation, students *may* have been processing the information in a complex manner; they may have been silently comparing what the teacher said with their prior knowledge; they may have been going beyond the information in the lecture by thinking of implications of what the teacher stated and comparing that to other knowledge that they had; they may have been generating analogies with other schema, and so on. Whatever students were doing during activities like this, it was done covertly. The instruction did not attempt to make thinking processes visible or provide explicit support for them.

There were plenty of occasions for students to ask questions about the content in Ms. Markfield's class. These occasions usually came after students had been watching and listening to a presentation (for example, teacher lecture or film). Figure 11 includes two examples of interactions that arose around students' questions. In the first example (lines 1-14), Stewart has asked a question about how

Figure 11: Classroom talk surrounding student-initiated questions in Ms. Markfield's class.

1 T: Stewart had such a good question. He said how does it (an
2 oxygen molecule) know how to go because the food and the air
3 both go down through the pharynx. How does it know which
4 one to go into? Has anyone got an idea? What do you think?

5 S1: Maybe the air when it's small has room to go through ...

6 Well that's a good guess but the way it works is at the top of
7 the trachea is a little trap door that shuts any time anything

other than air - so if I start to swallow a mouth full of water,
the trap door shuts and it reverts it down the esophagus. When
I go to take a breath, the trap door opens and the air goes down
and you can see, it's called an epiglottis, and you can see it on
that model there. You can see it on this one too, here. I'll
show you. Right here. (Ms. Markfield shows location on
physical model).

....

S: Can you get hiccups if your diaphragm starts to move real
fast?

T: I think it does something but I don't know, I'll get a better
explanation (from Jake's dad) than I can give you. What else?

S: What is that called when you are burping, is that involuntary?

T: The epiglottis is an involuntary thing. I can't control it. It
just controls itself and it's a wonderful thing because - have
any of you ever taken a big drink of something and a little goes
down your windpipe? What d'ya do?

S: You cough (several students coughing).

T: Because the body's reaction is to cough. You cough because the
body's reaction is to cough to get anything out of that trachea
that's not supposed to be in there. The only thing that's
supposed to be in the trachea is gas - oxygen and stuff like
that that's in the air. If you get anything solid in there, the
body coughs to get it out.

S: Could you ever get the tube - like let's say you were eating
food and it accidentally went down your windpipe?

T: Definitely, you can get - you sometimes get, if you choke on
something you might get a little piece of food get past the
epiglottis but you can easily swallow air. It's like Jake said,
if you swallow air, you can burp. ...

an oxygen molecule would know whether to enter the esophagus or the trachea. (It's interesting that he asks the question from the point of view of the air molecule rather than from the "human's" point of view.) The question was related to information in the lecture that was presented about 10 minutes previously. However, the students had just begun handling three physical models of various parts of the respiratory system when the question was asked. Ms. Markfield had finished her presentation before handing the models to the students. The student chose an appropriate time to ask his question. It is not clear whether he "held" the question for 10 minutes, that his interest was piqued by handling a model, or both. In any case, Ms. Markfield took up the question, she repeated it to the class and asked the class for an opinion. She got a response from one student, then answered the question herself.

There were several other choices that could have been made at this juncture. Rather than directing a general question to all students (lines 3-4), she could have asked Stewart what he thought. Alternatively, she could have asked the student who did respond to elaborate; she could have accepted the first student's response and without evaluating (as she did in labeling the response "a good guess") invited other students to respond; or she could have asked students how they would go about resolving this problem. Any of these alternatives would have been likely to reveal, to Ms. Markfield and to the students, the kind of thinking that students were doing at this point.. However, since the teacher's primary focus was on the knowledge to be acquired about the respiratory system, and not on thinking processes, none of those alternatives was likely to be chosen. These possible alternatives are mentioned here only to point out the consistency in Ms. Markfield's approach.

When she took up Stewart's question, it was as though she saw this as an opportunity to tell students something else that was relevant to the content objectives of the unit. Stewart's question was labeled "good" (line 1) because it furthered her agenda. Asking the students' opinions on the question seemed like a courtesy, but not like a genuine interest in what the students thought. Ms. Markfield allowed a short response and then answered Stewart's question herself. To have given students the floor, to have developed student voices in the conversation, so to speak (literally), would have opened up the possibility of negotiating with students where to go next either in this lesson or in the unit generally. This kind of negotiation would have implied the possibility of changing the predetermined content of the unit, a possibility that is not consistent with this way of teaching. Ms. Markfield kept the focus on those aspects of the respiratory system that were relevant to the unit's (previously determined) objectives, and did so with high levels of engagement from the students.

In the second example (lower half of Figure 11), students had been suggesting questions to be put to a medical doctor who Ms. Markfield was to talk with after school. Notice that, rather than developing and recording questions, Ms. Markfield was answering them as they arose. In doing so, she sent a message that Ms. Markfield either has the answers or will get them. This stance is an inherent part of teaching as practiced in Ms. Markfield's class. The student's role is to ask questions and the teacher's role is to answer them. These complementary role definitions also helped keep the focus on the specific content addressed by the unit.

In these examples, Ms. Markfield intervened regularly on the content but was practically silent on learning process. Ms. Markfield presented the content herself (in addition to having print, films, and models available) and kept the focus of the class on the content both by setting the learning tasks and by shaping the classroom talk.

Summary. Ms. Markfield kept relatively tight control on the academic content of the class and kept instruction geared to the content. She repeatedly gave clear and explicit descriptions of what she expected her students to know and then provided several opportunities for them to cover the content. Students had the content represented to them in at least four ways (lecture, film, physical models, simulations) over the four lessons. The pace of the lessons was brisk and the classroom environment was pleasant and businesslike.

Science in Ms. Stanford's class: The human nervous system

Classroom setting. Ms. Stanford worked with 24 fifth-grade students. Student desks were arranged in clusters of four or five desks each. During the observations, students usually worked in four-person face-to-face groups. The classroom itself was somewhat unusual in that it was neither self-contained nor part of a lager space that contained other classes. The front wall of the classroom contained a large chalkboard. One side wall had a window and a counter top with cabinets under it. The other side and the rear of the classroom were open to a corridor that bounded the classroom on two sides. This corridor provided access to other classrooms that were "beyond" Ms. Stanford's classroom. On the side, the classroom was partially separated from the corridor by a series of five-foot-high bookcases and coat racks. Most of the time, sounds from two nearby classrooms could be clearly heard.

Three of the observed lessons took place from 9:00 AM to 10:00 AM and one from 2:00 PM to 3:00 PM during the same week. These four lessons constituted all of the unit on the nervous system. The students had been studying other human systems but not with Ms. Stanford. Students rotated among several teachers for science instruction. In the first lesson, Ms. Stanford led a discussion to elicit students' ideas about the nervous system. Students generated and wrote down lists of "what I know" and "I wonder" about the nervous system; did a "concentration" memory experiment; and worked in cooperative groups on four pages of text on the nervous system. In the second lesson, Ms. Stanford led a discussion on brain function, students watched and later discussed a video on open brain surgery and epilepsy, and, in pairs, conducted experiments on reaction times and skin sensitivity. In the third lesson, students viewed and briefly discussed an animated film on the nervous system, and worked on several experiments on vision and "sensors."

Brief description of a lesson. The fourth lesson in the sequence was 52 minutes long. During analysis, the lesson was parsed into 9 activities. The boxed paragraphs that follow (Figure 12) represent the activities in the order they occurred. For each activity, a descriptive title, a synopsis, the activity function (prework, work, or completion) and duration (in minutes) are listed.

Figure 12: Outline of Activities in Lesson 4 from Ms. Stanford's class.

Activity A: Explanation of tasks for "extra credit." Ms. Stanford suggests several things that students could do on their own for extra credit on this unit. (These prework comments took 3:20).

Activity B: Ms. Stanford revisits the "I wonders." Teacher selects a few of the students' questions and gives relevant information. (This work session took 6:40).

Activity C: Explanation of grading. Ms. Stanford tells students what is taken into account in her grading of students performance on the unit. (This prework activity took 1:38).

Activity D: Review for test. Ms. Markfield conducts recitation on material to be covered on the test. (This work activity took 3:40).

Activity E: Directions for the test. (This prework activity took 1:17).

Activity F: Students take test on nervous system. Students work on two part test. First part is made up of objective items, second part calls for "short essays." (This work activity took 19:47).

Activity G: Transition to next activity. (This management activity took 1:18).

Activity H: Checklist of experiments for the unit. Ms. Stanford lists 5 experiments that are part of the unit. Students determine which they have not yet completed. (This prework activity took 7:32).

Activity I: Students complete experiments. (This work activity took 7:10).

Task and talk structures in the lessons. Most of the action in this unit took place around three kinds of encounters that students had with information about the human nervous system. First, the students engaged in "experiments" during each of the four lessons; second, they viewed videos during two lessons; and they read text from the "packet" as part of the first lesson. By examining classroom talk before, during, and after these activities, the kinds of thinking that students were expected to do can be described. Figure 13 presents the entire transcript of the prework leading up to students actually carrying out the "reaction" experiment.

Figure 13: Excerpt from classroom talk during Activity D, Lesson 2.

T: You're going to be going through two experiments today. One is to show your reaction times to see how quickly you can react to things and then the other one is to see how sensitive you are in various parts of your body. ... Now yesterday I did ask you, yesterday afternoon, to bring in a ruler so that you would be working with a partner and one of the tests that we'll be doing is using a ruler to show your reaction and I'm going to be passing out a sheet of paper just like this. Don't bother reading this unless you are really concerned about reading this just at that point. We'll be kind of discussing it after the actual experiment happens. I will wait until everyone's ready, thank you, but what you will be doing on this sheet is collecting information. And from this information, we'll be discussing it, not today but tomorrow, actually not tomorrow but on Thursday, we have a day off tomorrow. O.K. So, what we're going to be doing is taking your reaction times. Can I have somebody come up here please...

S: Why is it always girls you pick?

T: O.K. Why don't you sit down please. And what she's going to do is she's going to rest her right arm on the desk like this and her hand will be hanging over and it's important that she rest her arm on the desk when you do this, not right now but when you do this. The other person is going to take the ruler and they will take the ruler so that the "1" on the ruler is facing toward the floor and I'm going to see what her reaction time is. Meaning, I'm going to drop the ruler between her hands and I'm going to tell her how to position her hands and then when I drop it through, she's going to catch it and then wherever she catches it, for example, I have my fingers over here. The top of my fingers are closest to the number 8, so on the sheet of paper, ...

S: We'll put a number 8

T: you'll put 8 inches down. OK, under "right hand", because this is the one that she's taking the test on - or the experiment - her right hand. She will go through it and do it five times. You and your partner will do it five times. O.K. Then you will change arms and do it with the left hand. Let me show you how to do it. There are some key things to remember when you're doing it for it to work. O.K. First of all, the person needs to have her hand open. If you notice that their hand is not open enough, you should be able to put your fingers between the thumb and her fingers to make sure that it's open. Just a little more. There should be a little bit of room. O.K. ... What you'll need to do is put the ruler just like right directly about here, right directly above the finger and the thumb. Don't put it way up here because that gives them more time to react. Then all you do is drop it and they catch it. And when she catches it, she got closest to a 10, so she would put a 10 on her paper. After you have collected five trials on the right hand, five trials on the left hand, and recorded your information here, then what you will need to do is to find the average of the five trials. Who can tell me how you find averages? How many people know how to find averages. Some of us do, some of us don't. O.K. First of all, look around and notice the hands that are up. If you need help in finding averages, you can ask these people. I will explain it but if you forget, these are the people you can ask. O.K. as well as you can always ask me. What you will need to do is to add up, for example, if there was a 10, an 8, a 7, a 6 and a 10 again, you would add those five numbers up and let's say for convenience sake, that those five numbers added up to 30. Then I would take that addition, which is 30, after you added those five up and divide by 5 because you had five tries at it. That's for the left hand or right hand depending on what you're doing. If you have a remainder, forget the remainder. Some of them won't come out as nice and even as I explained. O.K. So just drop the remainder and just use it. Leave it as a whole number. O.K. So that's one experiment.

This excerpt took about five and one half minutes and was followed immediately, without questions or comments from students by an analogous description of the "second" experiment for the day. At the end of the descriptions and procedural demonstrations of both experiments (11:09 minutes), students began immediately to work, in pairs, on the experiments.

What conditions might be influencing student thinking during Activity D? Consider the experiment described in the excerpt. This "reaction time" experiment was not mentioned in the unit previously. The purpose of the experiment was presented as "to show your reaction times" (line 2, 16, 24); the relationship between this experiment and the theme of the unit was not specified. The actual procedure for the experiment was described and demonstrated clearly, however there was no interpretation given to the results (though a discussion was scheduled for two days later - lines 13-15). Also notice that reaction time was being measured in "inches" (lines 22-32). The conceptually complex relationship between numbers on the ruler and elapsed time was left for the students to puzzle through. In addition, there was no commentary by the role or meaning of "experimentation."

These are some examples of factors that contributed to the difficulty level of this activity for fifth graders. The task was conceptually very complex, the burden on students' memories was relatively high. The level of complexity, in itself, was not necessarily a problem. However, student thinking was almost entirely covert. It was very difficult to tell just what students were making of this. One might speculate that, for the ablest students, this was a challenging situation, and one that stimulated them to construct an interpretative framework for themselves. The difficulty of the task might have been mediated for some students by previous experiences in school science or informal education experiences in their communities. For students who had not developed self regulated thinking or who had not had prior relevant experiences for this task, the result was likely to be confusion and frustration or some "magical thinking" about science.

An examination of the transcripts for Lessons 3 and 4 revealed that there was very little classroom talk about the reaction data (in spite of the expectations set in lines 13-15). At the beginning of Lesson 3, students were asking questions about the test to be taken in Lesson 4. Ms. Stanford reassured the students that they were responsible for only the information from the packet that was covered in class. A moment or two later she referred to the experiments collectively, "If you've been listening in class, if you've been really concentrating on the information that we've been talking about, *if you've been doing the experiments and thinking about what those are all about*, I don't think you really have to worry about the test." About one minute later, while the discussion was still focused on evaluation of the unit, Ms. Stanford referred briefly to the "reaction time" data sheet (see Figure 14, lines 3-4, 6-8). Toward the end of Lesson 3, after students viewed a videotape on the nervous system (the tape had no information on

Figure 14: Excerpts from classroom talk in Lesson 3.

T: O.K. What you will be required to turn into me though
tomorrow before you take the test will be your packet, as well
as that single sheet. This single sheet, experiment sheet. ...
If you were not here for some reason and you did not get one, I
do have more of these because we're in a lot of different

places right now as far as the experiments go. O.K. But you are required to turn that in because I would like to see the information that you have recorded. Now, what we're going to do first today is see a videotape. ...

....

T: moving it up and down until that person kind of feels, you know, more sensitive. And then you're recording that information. O.K. And remember this is that kind of information you're supposed to record on the back of one of the sheets in your packet. The reaction test is the one with the ruler. The only thing I need to remind you of is to make sure the "1" on the ruler is facing down and be sure you're not starting the ruler when the person has opened their hands, like this. Don't start the ruler way up here, start at about this level and just release. If the person isn't opening their hand enough, you might want to make sure that that's opening. Because if you catch it right away, a lot of times that isn't a real good.indicator of what you've really done. If there's something wrong as far as placing it too high or too low in the hand or maybe the person had their hand or their fingers too close together like this. So that is what the reaction test is. Optic illusions ...

reaction times), Ms. Stanford was reminding students about the procedure for the "sensitivity" experiment when she made the only other reference to the "reaction time" experiment (Figure 14, lines 10-26). Lesson 4 did not have classroom talk directly relevant to the "reaction time" experiment. The point here is that doing the "reaction time" experiment may come to mean following the directions and producing the data sheet unless students have other experiences with experimentation that might extend or expand the meaning that was attached to the activity. Interpretation was either left entirely to the student or it was effectively hidden to students without "outside" resources. The issue here is not whether the instruction: (a) encouraged students to take the teacher's (or "textbook's") interpretation of the experiment without any access to the interpretative (meaning-making) process; (b) encouraged students to make their own interpretations by making the interpretative process explicit; or (c) provided coaching on the interpretative process <u>as well as</u> providing an "objective" interpretation by the teacher or textbook. In this case, there was no direct attention to interpretation of any kind during classroom talk.

Whether or not there was guidance on interpretation, students interpreted the experiment. Here are two examples from students as they worked in pairs on the "experiment" (see Figure 15, lines 5, and 14). In both of these cases, students assumed that the idea was to see which of their hands (right or left) was "fastest." Whether they made connections with the functions of the nervous system, or noted the conditional relationship between experimental procedures and conclusions to be drawn from data, was unclear.

Figure 15: Excerpts from classroom talk in Activity G, Lesson 3.

S: Do you want to go first?

S: It doesn't matter. Do you want to go first? O.K. Where am I?

S: Am I recording yours? Is that right?

S: Better do it over again because I got a "1".

S: Which hand had the fastest reaction? I had a 1, an 8, and then I
had a 7. O.K.

S: You have to put it on this table, remember?

S: O.K. This is my left hand, I'm starting.

S: 8 or 7?

S: I got 8

...

S: Concentrate.

S: 8.

S: Wait, what do you do?

some together? O.K. Good! Adam.

S: I counted up how many B's and A's there were and I just added them.

T: O.K. Any other strategies?

S: I say it over in my mind, 'cause then I can close my eyes and try to say it.

T: O.K. A lot of ways here that she said. She said it over, so repetition. She also closed her eyes to think about it. So she's visually "seen" it again. Good.

S: I - uh - I put them in three's, I put them in ABA's and I sort of like put it in an arrangement, then I can remember them.

T: O.K. So she actually grouped sets of three things. She put this in sets of three - A,B,A and B,B,B - now did you do that one as a group of three or just a group of two?

S: The first two I memorized pretty well and then I remembered A, A, B and then backwards - B,B,A.

T: O.K. So another different approach. Why do people have different ways of learning information?

S: Because nobody's the same.

T: And that's very, very true. No one is the same. We all learn differently. For some of you its very easy to memorize something like this because you have strategies and you have things you think about for learning information. For other people, it's really hard because you thought, "Look at all those letters, what am I going to do with all those letters. How can I possibly remember all those letters?" So you have a different way of learning or thinking about things. So what is really important for you is to really, really think about how your brain is going to really remember that information.

In this excerpt, students participated enthusiastically and provided several examples of their memory strategies. Notice that Ms. Stanford drew the students out and encouraged them to expand and extend their contributions to the conversation

S: You see which hand has the best reaction. The left hand.

S: Wait, I have to think a minute.

S: O.K., now.

While the experiments, in the main, did not include much explicit attention to thinking or meaning-making, there were instances during the four lessons when students' attention was drawn to cognitive strategies. For example, in Lesson 1, students looked at a sequence of letters for about 15 seconds and, then, when the letters were covered up, they wrote down as many as they could remember. This was followed by a brief (2:01 minutes) completion or debriefing activity. A portion of this activity is excerpted in Figure 16.

Figure 16: Excerpt from classroom talk during Activity L, Lesson 1.

T: O.K. Now I want you to take a look at what you put down. O.K., looking at what you have done, who can tell me what helps them remember the information? Who can give us some strategies for - tell us what helped you remember the information?

S: (two or three words that are inaudible)

T: Can you speak up just a little louder, please?

S: (three or four words that are inaudible)

T: O.K. Is it kind of how - did you regroup these letters? I mean, is that what you're saying? Or you just totally went through and counted all the "A's" and you totally went through and counted all the B's?

S: No.

T: No. Or did you say, "Oh, I have one "A", one "B", one "A", three "B's" is that what you're saying?

S: Yeah!

T: O.K. That's what I meant when I said maybe you could group (lines 9-12, 24-26, 29-31). The teacher's responses often repeated the students' statements and the teacher did not evaluate strategies. That is, the teacher took the role of facilitator in this particular interchange (an infrequrnt occurrence in the observed lessons).

Watching videos (three occasions in the four lessons) was one of the ways in which students were exposed to the content of the unit. In each case, there was little or no "setting up" of the videos, that is, they were simply shown. There were discussions after each video, and these followed a recitation-like format, or Ms. Stanford used these occasions to provide more content. The students apparently found the videos very engaging and attempted to start discussions of epilepsy and brain surgery on two different occasions.

Near the beginning of the first lesson, Ms. Stanford had students write lists of things that they "thought they knew" about the nervous system and then had them write things they wanted to know ("I wonders"). This did get at some of their prior knowledge and constituted two thirds of the KWL strategy, however the third step did not occur. In fact, the students' lists were collected immediately after being generated. Subsequently, as part of the same lesson, Ms. Stanford selected a few of the "I wonders" to read to the class, the lists were not mentioned again until they were handed back to students near the beginning of Lesson 4. At that point, Ms. Stanford evaluated whether or not the "I wonders" had been answered by the instruction but did not query the students on this point or hold them accountable for their own learning. On two points that students had listed as "I wonders" and that, in the teacher's judgment, had not been addressed in the class, Ms. Stanford had gone to reference books, gotten the information and now presented it to the class. In providing this information, Ms. Stanford did the cognitive work (monitoring the questions to be answered, finding other sources of information to answer the questions, acquiring the information, putting the information into her own words, and reporting the information to the class) that one would ordinarily want students to do.

Summary. Instruction in Ms. Stanford's class seemed to place high cognitive demands on students, not so much for the content, as for identifying what was to be learned and for providing your own support for learning it. Although there were a few examples of the teacher taking the role of facilitator of student thinking, the primary role was that of classroom manager. In a secondary role, Ms. Stanford was a source of content information. She chose to have the videos, the packet, and the experiments "carry" most of the content. Students had relatively few occasions for interpreting, or commenting on, either information about the nervous system, thinking processes, or the processes of science.

Instructional approaches in the classrooms

Having examined the task and talk structures in four lessons in each of the four classes, what can we say about instructional influences on student thinking? This question is addressed by summarizing the analyses on (a) activity structures, (b) talk structures, and (c) several themes that arose as the study progressed. Our intention is to identify and describe distinctions among the instructional profiles in the classrooms and interpret these distinctions in terms of the kinds and amounts of student thinking that are likely to be practiced.

Task and activity structures in the classrooms. During the observed lessons, all classrooms showed considerable variety in activity structures both within individual lessons and among lessons[4]. The duration of lessons in Ms. Markfield's (53 minutes) and Ms. Stanford's (52 minutes) classes were somewhat longer than those in Ms. Landis' (45 minutes) and Ms. Candel's (41 minutes) classes. Activities changed more quickly in the Landis/Candel classes (about every three minutes on the average) than in the Markfield/Stanford classes (about every five minutes on the average) indicating a somewhat faster pace in the former classes.

The time that students spent in activities that were coded as prework, work, and completion was aggregated over lessons and converted to percentages of total lesson time (see Figure 17). These proportions give an idea of the relative "mix" of

Figure 17: Percentages of lesson time by activity function[1].

Class	Activity functions		
	Prework	Work	Completion
Ms. Landis	30	29	33
Ms. Candel	19	49	29
Ms. Markfield	15	67	12
Ms. Stanford	31	60	7

1 Percentages of time in the management function were small and have been omitted, therefore row totals are not equal to 100 percent.

4 Information in this section of the report is summarized from the tables and text in Appendix C.

activity functions presented to students. For example, students in Ms. Landis' class spent about equal portions of their lesson time on each of the activity functions. That is, students spent about one-third of the time on prework activities (listening to a description of the work, talking about the goals of the work, accessing prior knowledge that might be relevant to the work, developing procedures to accomplish the goals, and so on), about one third of their time on work activities (designing a questionnaire, compiling data from interviews, drawing conclusions from the data, and so on), and about one third of their time on completion activities (reviewing what they had done, interpreting the meaning of the work, reflecting on the way they had gone about the work and the results that were produced, answering questions about the content that had been covered, writing about the work, and so on).

While the proportions of time spent in the three activity functions should not be over interpreted (since quite different student actions can be called for by different examples of prework, work, and completion), this profile does provide a crude index of the overall instruction in a classroom. It is interesting to note that, on the one hand, Ms. Landis' and Ms. Candel's classes were fairly similar and, on the other hand, Ms. Markfield's and Ms. Stanford's classes were also fairly similar but the two pairs differed from each other. The primary difference was in the portion of lesson time spent on completion activities. The Landis/Candel classes spent more time on completion activities and this time apparently "came from" work activities. Since completion activities often require students to reflect on, or make sense of, what was done during the work activity, students in the Landis/Candel classes appear to have had more occasions for talking about and expressing their thoughts on their work.

Activity formats were simplified to three categories: discussions where teacher talked more than students (teacher-talk); discussions where students talked more than teachers (student-talk); and a category for everything else[5] (other). Using these categories, there were no strong patterns in the data. However, the teacher-talk format was used considerably less by Ms. Candel's class than the other three classes and the student-talk format was used considerably less by Ms. Stanford's class than was the case for the other classes.

When activities were rated for cognitive complexity, striking differences were found. Students in the Landis/Candel classes spent about one third of their time in

[5] Since management activities accounted for relatively small amounts of time and were evenly distributed across classes, management format is ignored in this discussion.

activities that were rated higher than the knowledge/comprehension levels of Bloom's taxonomy while students in the other classes spent about one eighth of their time is activities at this level of complexity. As a result, students in the Landis/Candel classes had substantially more time in activities that required higher level thinking skills.

Students in three of the classes spent about two fifths of their time on activities that involved a concrete product (i.e. writing, doing paper and pencil exercises, constructing physical objects, and so on). The fourth class (Ms. Landis' class) spent about one fifth of their time in this way. When students worked on activities with concrete products, most often the products were completed by individual students. With the exception of Ms. Stanford's class, students also spent some time on group products.

When students worked on concrete products, the degree of influence that students had on "specifying what the product would be like" varied. In the Landis/Candel classes, students had either a moderate or high level of influence on specifying their products. To say it another way, these students almost never (for the 8 lessons observed in these two classes) worked on products that were fully specified by the teacher or another "external" agent. In Ms. Markfield's class , students spent about one quarter of the instructional time working on products that were specified by someone else and about one eighth of the time on products where they had a moderate level of influence on product specification. Students in Ms. Stanford's class worked almost exclusively on products that were specified by someone else. We speculate that where students had greater input into product specification, they were likely to have higher motivation to learn and higher levels of "ownership" of their school work and therefore to think more and differently about their schoolwork.

In examining the overall task structures, we found that the structures in Ms. Landis' and Ms. Candel's classrooms were different from those in Ms. Markfield's and Ms. Stanford's classrooms. Within these two pairs, the former were somewhat more alike than were the latter. Task structures in the Landis/Candel classes compared to the Markfield/Stanford classes were faster paced (activities were shorter); students spent more time in completion activities and less time in work activities; the cognitive complexity of the activities was generally higher, and students had more influence on the design or specification of the products they produced. In general terms, these differences represented more and higher-level thinking opportunities for students.

Talk structures in the classrooms. Within the task structures in classrooms, interactions among students and between students and teachers varied considerably. While students talked less than teachers in all classes, students generated the greatest amount of talk in Ms. Candel's class and increasingly less talk in Ms. Landis,' Ms. Stanford's, and Ms. Markfield's classes.

Students listened to lectures on several occasions in Ms. Markfield's class; the recitation pattern occurred in both M. Stanford's and Ms. Markfield's classes; and teacher-led discussions occurred often in all the classes. Student-to-student discussions occurred most often in Ms. Landis' and Ms. Candel's classes, on several occasions (especially during "experiments") in Ms. Stanford's class, and infrequently in Ms. Markfield's class. Students made extended responses more often in the Landis/Candel classes and made short one or two word responses more often in the Markfield/Stanford classes. Students also gave summaries in their own words and attempted interpretations of classroom work more often in the Landis/Candel classes compared to the Markfield/Stanford classes. Teachers made direct references to thinking skills in terms of specific strategies for learning, metacognition, and self regulation on many occasions in Ms. Landis' and Ms. Candel's classes, on several occasions in Ms. Stanford's class and rarely in Ms. Markfield's class. There were more high level questions, longer student answers and less evaluation of answers in the Landis/Candel classes compared to the Markfield/Stanford classes.

These patterns in classroom talk suggest that appropriate participation for students was different from class to class and that there was both more active participation and more opportunity to express student thinking in the Landis/Candel classes compared to the Markfield/Stanford classes.

The meanings of teaching and learning in the classrooms. Through analyses of task and talk structures in the classrooms, differences among the classes in academic activities and patterns of teacher-student interaction were described. While each of the classes was unique, when individual characteristics of instruction were examined differences between the Landis/Candel classes and the Markfield/Stanford classes were sufficiently consistent and frequent to suggest a larger pattern. In this section of the report, we outline a larger pattern and use this pattern to interpret differences between the pairs of classes.

Two views of the purposes of instruction in the classrooms. From the observations, the apparent primary focus of instruction in the Markfield/Stanford classes was acquisition of knowledge and understanding about the respiratory and nervous systems. Students had repeated opportunities to learn the names and functions of human organs, the systems to which they belonged, what each of the systems accomplished in the body, and some implications of various diseases and malfunctions of organs for human health. In these classes, the *de facto* purpose of instruction was to acquire subject matter content. In the Landis/Candel classes, students acquired content *and* studied how to acquire content. That is, students not only spent time studying Colorado history and human biological systems, they also explicitly acquired knowledge about, and skills in performing cognitive tasks. It may be more accurate to say that the relative emphasis on these purposes was very different in the pairs of classes. In the Landis/Candel classes, students spent, more or less, equal amounts of time on studying content *and* studying the means of acquiring content while in the Markfield/Stanford classes, students spent almost all of their time studying the content.[6] This distinction has several implications for the kinds and amounts of thinking that students were encouraged or invited to do in the classrooms.

Two views of knowledge in the classrooms. To the extent that the purposes of instruction were different in the pairs of classes, the concept of knowledge itself was represented somewhat differently. In the Landis/Candel classes, where students explicitly studied content and thinking skills, there was considerable opportunity for students to gain insight into the relationship between knowledge and how-knowledge-is-made. For example, by acquiring and applying the strategy of experimental inquiry or the "habits of mind," students actually engaged in creating knowledge. They spent substantial amounts of instructional time on interpretation of data. That is, students did some portion of the interpretation rather than having interpretation done for them (and therefore not necessarily realizing that interpretation was carried out at all).

In the Landis/Candel classes, teachers often "pulled for" more than one interpretation of data. When classroom conversations included multiple interpretations, participants could come to grips with the role of agreement in constructing knowledge. In the Markfield/Stanford classes, in almost all instances, only one interpretation was considered and the process of interpretation was thereby hidden to participants. In the Landis/Candel classes, different students often made interpretations. Indirectly, this procedure encouraged students to think that knowledge can come from a number of sources. In the Markfield/Stanford classes,

6 On this point, instruction in Ms. Markfield's class had a stronger focus on content than was teh case in Ms. Stanford's class.

where almost all interpretation was done by, or overtly sanctioned by, the teacher, knowledge could appear to students to have but one source.

The patterns of turn taking in the classes could also have influenced students' views of knowledge. In the Landis/Candel classes, there was more student-to-student talk, even in whole class situations, thereby distributing the interpretation function more evenly among students and the teacher. By comparison, when students talked in whole class settings in the Markfield/Stanford classes, turn taking alternated regularly between teacher and student. This latter pattern gave teachers more opportunities to evaluate students' comments and thereby make it appear that knowledge resided with teachers and not with students.

In the Landis/Candel classes, students spent substantial amounts of time and effort on framing problems, posing problems, or identifying something about a domain that they would like to know as well as on solving problems. By regularly generating both questions and answers, students have the possibility of understanding the profound relationship between the two. In the Markfield/Stanford classes, students spent substantial amounts of time and effort on problem solving but relatively little on problem posing. In this case, students could have inferred that question-asking was less important than question-answering.

These kinds of differences, some subtle, some not so subtle, represent the nature of knowledge very differently from one pair of classes to the other. By acquiring knowledge primarily from the teacher, texts, and videos, without participating directly in interpretation of phenomena, students in the Markfield/Stanford classes were more likely to see knowledge as external, objective, and static. From this point of view knowledge is passed, or transmitted, from one person to another like a physical commodity. On the other hand, having access to some elements of the knowledge-making or sense-making processes, students in the Landis/Candel classes were more likely to see knowledge as internal, subjective, and dynamic. These latter students were also more likely to acknowledge the role of human beings in making knowledge in the first place.

Both of these views of knowledge have long histories and the appropriateness of valuing one view more highly than the other is far from obvious. In spite of this ambiguity, students in the Landis/Candel classes and students in the Markfield/Stanford classes are immersed in settings that differentially foster the "internal" view and the "external" view respectively.

As an example of this differentiation of views on the nature of knowledge, consider the analysis of the questionnaire data in Ms. Landis' class. In that situation, the teacher did not interpret the data, rather the teacher supported students as they applied the procedures of experimental inquiry. There was no predetermined correct answer to the questions that students were addressing. The students were left then, with the distinct possibilities of (a) developing answers to their content questions and (b) seeing that their answers rested on the data themselves, the conditions under which the data were collected, and the cognitive operations that generated meaning from the data. From this example, students in Ms. Landis' class were more likely to conceptualize knowledge as internal (since knowledge resides more in their interpretation than in the data), subjective (since not everyone in the class had the same interpretation), and dynamic (since the answers to questions could change over time or over questionnaire respondents).

In contrast, consider the "experiment" on blind spots in human vision conducted in Ms. Stanford's class. In this case, the phenomenon was described by the teacher and explained or interpreted for the students *before* they collected any data. When students carried out the procedures, there was no sense of surprise or of "not knowing." In effect this implementation of an experiment made it seem like something you do to confirm what is already known. (One had the feeling while watching this "experiment" unfold that, had the data not confirmed the proposition, the data would have been suspect, but not the proposition.) From this example, students in Ms, Stanford's class could have taken knowledge to be external (knowledge resides outside the heads of human beings, objective (knowledge exists separately from human beings), and static (if you do it right you always get the same answer).

Two views of teaching in the classrooms. There was plenty of variety in teaching both within and across the four classrooms. While most of the characteristics described in hits section could be found at least once in each of the classrooms, there were several patterns that differentiated the Landis/Candel classes from the Markfield/Stanford classes. One pattern involved a cluster of teacher role characteristics. Teachers in the Landis/Candel classes operated primarily out of a facilitator's role. That is, they allowed the academic tasks and activities to carry much of the disciplinary content to be learned; they created and maintained conversations among the students during which students were encouraged to make their thinking public in a non-evaluative environment. They often asked students to "say more," to extend their responses, and to think-out-loud. During interactions with students, teachers often explicitly referred to "how to find out" rather than giving information, teachers often answered questions with questions. In these classes, teachers asked a lot of open ended questions. They also used pedagogical techniques like cooperative learning to move the locus of cognitive work to the students. In cooperative learning groups, students generated questions to pursue, summarized what they had learned and struggled to articulate what they were learning. Teachers often had students express their prior knowledge about topics.

In the Markfield/Stanford classes, teachers operated primarily as a source of knowledge about the content. Teachers, in the main, did not allow the academic tasks to carry the content but rather took on that role themselves. Teachers intervened on the content at almost every opportunity, extending students ideas, correcting misunderstandings and generally mediating the content. They focused on the content and not on learning processes. Teachers interpreted the curriculum for the students. Teachers also reminded students about tests and testing related to the content. When interacting with students, teachers usually answered questions with information. Teachers rarely elicited prior knowledge.

Two other aspects of teaching that distinguished one pair of classes from the other arose in the analysis. First, teachers in the Landis/Candel classes, on many occasions acted as the metacognitive coach for the class. These teachers frequently drew students attention to how they were thinking, they asked students for evidence regardless of whether students' statements aligned with orthodox knowledge, and they maintained a fast pace during class. Teachers in the Markfield/Stanford classes, acted as content experts. These teachers presented content, they responded to students questions with information about content, and they often commented on the correctness of students statements. It should be noted that all of the teachers were very knowledgeable about the subject matter they were teaching, but this knowledge was expressed directly in one pair and only indirectly in the other.

The second distinction is related to the question "What drives instruction?" In the Markfield/Stanford classes, instruction was driven by the content. These classes were practicing what might be thought of as "supply side teaching." That is, you start with the knowledge to be taught, and design lessons to teach that information with relatively little attention to client demand. In the Landis/Candel classes, instruction appeared to be driven by content *and* the students prior knowledge and interests. Within limits then, the curriculum was, to some degree, "negotiated with," or modified by, students in the Landis/Candel classes and less so in the Markfield/Stanford classes.

Two views of learning in the classes. For students in the Landis/Candel classes, learning meant acquiring knowledge about content (in this case, acquiring knowledge about Colorado history or the circulatory and respiratory systems) and acquiring strategies for manipulating, expanding, and representing that knowledge. Students were to comprehend and use specific strategies for learning as they were acquiring subject matter knowledge. Conversations in the classes focused on content and on the thinking strategies that could be used in solving various problems associated with the content. So, in addition to learning subject matter concepts and relationships among those concepts, these students explicitly studied about and practiced experimental inquiry, visualization, KWL, elementary data analysis, simulating dynamic systems, and so on.

In the Markfield/Stanford classes, learning meant the acquisition of knowledge as represented by the curriculum and interpreted by the teacher. To a certain extent, students were encouraged to adopt both content knowledge *and* the perspective from which the content was being presented. Since only one interpretation of the material was typically represented in the classroom, many students may have adopted this representation of reality as reality itself. Students learned the names and labels associated with the subject matter and examined relationships among the elements of the respiratory and nervous systems. They also participated in simulations, KWL, and experiments, however these strategies for representing and inquiring about knowledge were not explicitly part of what students were expected to learn or be tested on.

In the Landis/Candel classes, students were expected to make sense of bodies of information, they were to organize and reorganize, present and represent information, and to explicitly build upon their prior knowledge. In the Markfield/Stanford classes, students were primarily expected to adsorb the content with relatively little attention to prior knowledge.

In the Markfield/Stanford classes, students spent large amounts of time listening to presentations of content and responding to recitation-like questions. In the Landis/Candel classes, students also spent time on these activities but spent substantial amounts of time on interpretation of data, reflecting on what they had learned, and extending and summarizing their knowledge.

In one sense, the pairs of classes represented two different distributions of cognitive processing. In the Markfield/Stanford classes, there was a kind of specialization where teachers did most of the higher level thinking and students did most of the watching and listening. A portion of what were teachers' cognitive activities in the Markfield/Stanford classes (interpretation, organizing and presenting the content, and so on) were distributed to the students in the Landis/Candel classes. To the extent that this redistribution takes place, classrooms become more thoughtful places to live and work from the students point of view. This statement is true for teachers as well since, new high level tasks like conversation management and coaching take the place of the higher level thinking functions that are distributed to students.

Cooperative learning methods were used in all of the classes, extensively in the Landis/Candel classes and on several occasions in the Markfield/Stanford classes. However, the method was used differently in the pairs of classes. In the Landis/Candel classes, cooperative learning was used as one way for students to identify their prior knowledge, to acquire, refine and extend their knowledge, and to reflect on what they had learned and how they had learned it. In the Markfield/Stanford classes, there were always one or more elements missing from the implementation so that the cooperative learning method became an alternative classroom management procedure more than an instrument of social learning theory. That is, classes used this method in ways that aligned with the purpose of instruction, view of the nature of knowledge, and the teaching and learning frameworks that guided instruction in the classes.

Coverage of content in the classrooms. The observed lessons were longer in duration in the Markfield/Stanford classes compared to the Landis/Candel classes. Although differences in duration may be important for some purposes, these differences are not particularly relevant for this study. However, discounting differences in duration, there was a second reason that content coverage varied between the pairs of classrooms. The single focus on subject matter in the Markfield/Stanford classes compared to the dual focuses on Subject matter and thinking skills in the Landis/Candel classes resulted in different content coverages. While it is difficult to make a useful assessment based on four lessons per class, there was a noticeable difference in content coverage. This difference showed up most clearly in Ms. Markfield's class where students covered the subject matter material more than once during the four lessons.

Content coverage becomes especially important when the quality of instruction is measured by student performance on achievement tests. For short term tests of knowledge and comprehension of the subject matter, content coverage has been shown to have a sizable effect. That is, students tend to score higher when the content of the test is well-aligned with the content of instruction. For example, the repeated coverage of subject matter material, combined with the clarity of goals, fast pace, and single focus on content that characterized Ms. Markfield's class would be expected to be especially effective on traditional measures of achievement.

The predictability of content coverage could also be expected to vary between the pairs of classes. For the Markfield/Stanford classes, the subject matter was known in advance of instruction. The content was prescribed during unit planning and, for all intents and purposes, did not change. However, to the extent that the curriculum content is negotiated with students in the Landis/Candel classes, a portion of the content will only be determined as the instruction unfolds.

<u>Summary</u>. This study examined instructional processes in four elementary school science classrooms. Two of the classrooms had had extensive training in integrating subject matter content and instruction on thinking/learning skills (see Dimensions of Learning; Marzano ....). Differences in task and talk structures were described. These differences differentiated classrooms implementing subject matter integrated with thinking skills from classrooms focused on subject matter with relative consistency on: (a) purposes of instruction, (b) views of the nature of knowledge, (c) views on teaching and learning, and (d) content coverage. There was sufficient consistency across pairs of classrooms on these dimensions that the classrooms represented two substantially different instructional paradigms. Classes implementing subject matter integrated with thinking skills used a knowledge construction metaphor or framework while the classes focusing on subject matter used a knowledge transmission metaphor or framework.

APPENDIX T

EXAMPLES OF WILLOW CREEK REPORT CARDS

P Indicates presented
+ Indicates satisfactory performance
✓ Indicates improvement is needed

P	HABITS OF MIND	1	2	3
	Self-Regulated Thinkers			
	Think about their thinking			
	Plan			
	Know and use necessary resources			
	Listen to and use feedback			
	Judge the results of their actions			
	Critical Thinkers			
	Seek accuracy			
	Seek clarity			
	Are open-minded			
	Restrain impulsiveness			
	Take a stand when they have good reasons			
	Care about the feelings and abilities of others			
	Creative Thinkers			
	Work hard even when answers/solutions aren't easy			
	Push the limits of their knowledge and abilities			
	Self-evaluate using their own standards			
	See things in new and different ways			

PARENT'S SIGNATURE DATE

1st Marking Period ______________________ __________

2nd Marking Period ______________________ __________

Placement for 19 __ - 19 __: Grade ________

WILLOW CREEK ELEMENTARY SCHOOL

Cherry Creek Schools
7055 South Willow Way
Englewood, Colorado 80112
773-1765

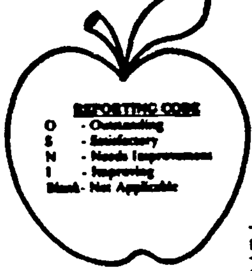
INDIVIDUAL PROGRESS REPORT OF

____

Grade 1
School Year 19 __ - 19 __

TEACHER ______________________________

Through this progress report we present you with a picture of your child's progress in subject matter areas, as well as your child's social habits and achievements. We wish to call to your attention the fact that no two individuals are alike in all respects, and we must be conscious of this at all times. Therefore, please do not compare your child with other children but measure according to his or her ability in the assigned grade level. Many hours are devoted to fully understanding both the child's strengths and weaknesses. The school and the parents working together will best accomplish this end.



ATTENDANCE AND PUNCTUALITY

	1	2	3
Days Present			
Days Absent			
Times Tardy			

Teacher ______________________________

READING	1	2	3
Reading Level			
Comprehension			
Vocabulary Development			
Word Attack Skills			
Fluency			
Effort			

HANDWRITING/SPELLING	1	2	3
Forms letters correctly			
Writes neatly and legibly			
Spells words correctly on tests			
Spelling application			
Effort			

+ Indicates satisfactory performance
✓ Indicates improvement is needed
I Indicates improving

LANGUAGE ARTS	1	2	3
PREWRITING: Initiates own writing			
WRITING: Produces meaningful writing			
REVISING: Revises ideas when appropriate			
EDITING: Edits ideas when appropriate			
APPLICATION OF ENGLISH SKILLS: Capitalization			
Punctuation			
Complete sentences			

Individual Report of ______________________________

+ satisfactory performance
✓ improvement is needed
I improving

Teacher ______________________________

MATHEMATICS	1	2	3
Grade Level:			
Concepts: Knows basic math facts, (addition, subtraction)			
Problem solving			
Money			
Clocks			
Effort			

WORK HABITS/PERSONAL DEVELOPMENT	1	2	3
Uses good learning skills			
Follows directions			
Uses time constructively			
Completes work on time			
Respects property			
Accepts responsibility			

SOCIAL STUDIES	1	2	3
Participates in activities and discussions			
SCIENCE			
Participates in activities and discussions			

WILLOW CREEK ELEMENTARY SCHOOL

Cherry Creek Schools
7055 South Willow Way
Englewood, Colorado 80112
773-1700

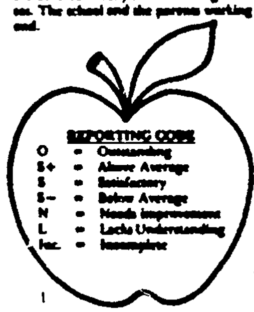
INDIVIDUAL PROGRESS REPORT OF

____

Grade 4
School Year 19 __ - 19 __

TEACHER ______________________________

Through this progress report we present you with a picture of your child's progress in subject matter areas, as well as your child's social habits and achievements. We wish to call to your attention the fact that no two individuals are alike in all respects, and we must be conscious of this at all times. Therefore, please do not compare your child with other children but measure according to his or her ability at the assigned grade level. Many hours are devoted in fully understanding both the child's strengths and weaknesses. The school and the parents working together will best accomplish this end.



ATTENDANCE AND PUNCTUALITY

	1	2	3
Days Present			
Days Absent			
Times Tardy			

Individual Report of __________________________

SOCIAL STUDIES	1	2	3	
Units:				Teacher
Maps and Globes				
Colorado: Geography				
History				
Government				
Effort				

SCIENCE/HEALTH	1	2	3	
Units:				Teacher
Human Body				
Earth Science				
Physical Science				
Life Science				
Here's Looking at				
Effort				

	PARENT'S SIGNATURE	DATE
1st Marking Period		
2nd Marking Period		

Placement for 19 __ - 19 __ : Grade ________

Individual Report of __________________________

+ = Above Average
✓ = Satisfactory
E = Experiencing Difficulty
! = Improving

Teacher __________________________

LANGUAGE ARTS

READING	1	2	3
Grade Level			
Effort			
Vocabulary			
Comprehension			
Skill Development			
Novels			

WRITTEN LANGUAGE	1	2	3
Effort			
English skills			
Spelling - Test			
Spelling - Application			
Handwriting			
Writing process			

PERSONAL AND SOCIAL DEVELOPMENT	1	2	3
Respects rights and property of others			
Is courteous and cooperative			
Practices self-control			
Displays positive attitude			
Relates well to others			

School Year 19 __ - 19 __

TEACHER __________________________

MATHEMATICS	1	2	3
Grade Level			
Effort			
Knows Basic Facts:			
Addition			
Subtraction			
Multiplication			
Division			
Proficiency in Skill Areas, Units			
Place Value			
Addition			
Subtraction			
Multiplication			
Division			
Problem Solving			
Geometry			
Fractions			
Graphing			
Strength			

WORK/STUDY HABITS	1	2	3
Works well independently			
Works well in a group			
Follows directions			
Is well organized			
Consistently completes work on time			
Uses time wisely			
Listens attentively			
Works carefully and accurately			
RESEARCH PERFORMANCE ASSESSMENT			
✓ = completed			

Key
+ = Above Average
✓ = Satisfactory
E = Experiencing Difficulty
! = Improving

HABITS OF MIND	1st Trimester		2nd Trimester		3rd Trimester	
Self-Regulated Thinkers						
Think about their thinking						
Plan						
Know and use necessary resources						
Listen to and use feedback						
Judge the results of their actions						
Critical Thinkers						
Seek accuracy						
Seek clarity						
Are open-minded						
Restrain impulsiveness						
Take a stand when they have good reasons						
Care about the feelings and abilities of others						
Creative Thinkers						
Work hard even when answers/solutions aren't easy						
Push the limits of their knowledge and abilities						
Self-evaluate using their own standards						
See things in new and different ways						

BEST COPY AVAILABLE

P - Presented
+ Satisfactory
✓ Needs Improvement

P	HABITS OF MIND:	1	2
	Self-Regulated Thinkers		
	Think about their thinking		
	Plan		
	Know and use necessary resources		
	Listen to and use feedback		
	Judge the results of their actions		
	Critical Thinkers		
	Seek accuracy		
	Seek clarity		
	Are open-minded		
	Restrain impulsiveness		
	Take a stand when they have good reasons		
	Care about the feelings and abilities of others		
	Creative Thinkers		
	Work hard even when answers/solutions aren't easy		
	Push the limits of their knowledge and abilities		
	Self-evaluate using their own standards		
	See things in new and different ways		

PARENT'S SIGNATURE DATE

First Marking Period____________________ __________

Placement for 19 __ - 19 __

Grade_________

WILLOW CREEK ELEMENTARY SCHOOL

Cherry Creek Schools
7956 South Willow Way
Englewood, Colorado 80112
773-1795

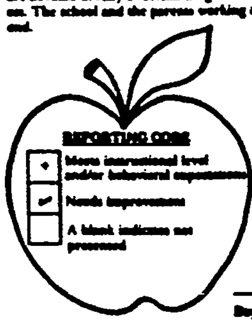
INDIVIDUAL PROGRESS REPORT OF

____

Kindergarten
School Year 19 __ - 19 __

TEACHER ____________________________

Through this progress report we present you with a picture of your child's progress in subject matter areas, as well as your child's social habits and achievements. We wish to call to your attention the fact that no two individuals are alike in all respects, and we must be conscious of this at all times. Therefore, please do not compare your child with other children but measure according to his or her ability in the assigned grade level. Many hours are devoted to fully understanding both the child's strengths and weaknesses. The school and the parents working together will best accomplish this end.



ATTENDANCE AND PUNCTUALITY

	1	2
Days Present		
Days Absent		
Times Tardy		

SOCIAL AND EMOTIONAL DEVELOPMENT	1	2
Knows address		
Knows phone number		
Works and plays well with other children		
Works well with adults		
Participates in Show and Tell		
Attends to personal needs (ties shoes, manages wraps alone)		
Adjusts to new situations		

COGNITIVE DEVELOPMENT READING READINESS	1	2
Can classify objects by group		
Places pictures in sequential order		
Identifies rhyming words		
Recognizes all upper case letters		
Recognizes all lower case letters		
Can match beginning sounds to letter names		
Can match ending sounds to letter names		
Recognizes basic sight words		

WORK/STUDY HABITS		
Completes task on time		
Takes pride in work		
Listens to and follows directions		
Works independently		
Listens and concentrates for a reasonable length of time		

WRITING PROCESS		
PREWRITING: Demonstrates willingness to write		
SHARING: Willingly shares writing		

MATHEMATICS		
Recognizes basic colors		
Recognizes basic geometric shapes ○ □ ▭ △ ⬭		
Identifies numerals (1-10)		
Understands number concepts (1-10)		
Understands equal, more than, less than		
Can rote count to		
Recognizes penny, nickel, dime, quarter		

MOTOR DEVELOPMENT FINE MOTOR SKILLS - Small Muscles		
Writes first name legibly		
Writes last name legibly		
Writes numerals 1-10 legibly		
Can use materials effectively: 1. Pasting		
2. Cutting		
3. Coloring		
4. Painting		
Large Muscles		
Participates in physical education		

CREATIVE SKILLS		
Participates in music activities		
Participates in art activities		