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DATE November 20 19 81

Joanne Anania — 6/16/39
Author — Birth Date

The Effects of Quality of Instruction on the Cognitive and Affective Learning of Students
Title of Dissertation

Education	Ph.D.	December 1981
Department or School	Degree	Convocation

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THE EFFECTS OF QUALITY OF INSTRUCTION ON THE COGNITIVE AND AFFECTIVE LEARNING OF STUDENTS

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE SOCIAL SCIENCES
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATION

BY

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CHICAGO, ILLINOIS

DECEMBER, 1981

ACKNOWLEDGMENTS

I was especially fortunate in having Benjamin Bloom as chairman of my committee. From the initial exploratory discussions to the completion of the manuscript for the dissertation, Professor Bloom's challenging questions, perceptive comments, and clear understanding of the broader implications of my research provided encouragement and direction. It was a privilege and an invaluable experience to have worked with an exemplary teacher.

I want to thank Professor John Bormuth for his suggestions and for the careful attention he gave to my treatment of the data. I also want to express appreciation for the assistance and support I received from Professor Roger Pillet.

The principal, faculty, and students of the school where the studies were conducted also deserve my gratitude. Their cooperation and patience were essential, and they contributed both, unfailingly.

The understanding and help I received from colleagues at St. Xavier College are greatly appreciated. I am especially indebted to Susan Beal, whose expertise in math education and generous contribution of time proved indispensible during the fourth and fifth grade studies. I also want to thank Cheryl Dignan for the long hours and hard work she contributed to the eighth grade study.

The research would have been an impossible undertaking had it not been for the enthusiasm and diligence of the following education students who observed time-on-task, served as tutors, and helped in innumerable important ways: Carol Adkins, Dottie Adomaitis, Donna Ahlert, Jan Banasiak,

Elizabeth Barker, Kathy Blough, Cindy Blum, Mike Braband, Eileen Brosnan, Kathleen Brown, Eileen Casey, Mary Kay Coffey, Mary Ann Cusack, Sandi Delisio, Celeste Enochs, Chuck Fiala, Diane Fitzgibbons, Justine Fudala, Sharilyn Harm, Cheryl Hill, Ruth Ihnat, Elaine Kotsiviras, Kathleen Malone, Susan McNeela, Kathryn Miller, Mary Mrozek, Kathleen O'Brien, Denise Pfeifer, Janet Pinotti, Roberta Reynolds, Marty Rynne, Mary Beth Sexton, Joanne Trotta, Sheila Tuton, Debbie Vlahakis.

During the statistical analysis of the data, I received advice and assistance from two friends, Michael O'Brien and Susan Beal. Both took time away from their own work to help me.

Throughout the long period of research and writing, my husband and daughter's unceasing encouragement and confidence in me sustained my efforts. In addition to the countless, intangible contributions each made to my work, both Michael and Francesca helped in the development and testing of materials for the probability and cartography units. I am grateful to both for their support and assistance.

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CHAPTER I

INTRODUCTION

Most of what is known about the effects of instruction on the cognitive and affective learning of individuals has been gained from research on students receiving conventional group instruction. Group-based instruction is an economic necessity for any society attempting to educate a large segment of its population. However, it is not an appropriate context in which to determine the full extent of what individual students are capable of learning. As Bloom (1976) has noted, "we can only determine the full limits of what the student can and will learn when we have provided qualities of instruction which are optimal for the individual learner" (p. 136). Conventional group instruction cannot provide optimal qualities of instruction for all members of the group because of individual differences in students' cognitive and affective entry characteristics. Conventional instruction is not designed to alter these entry characteristics in ways which could enable most of the students to attain high levels of achievement and positive affect toward learning. Also, teachers are rarely able to provide optimal learning conditions for all the students in a classroom.

The studies presented here examine the degree to which the learning outcomes students attain are a function of the quality of the instruction they receive. The cognitive and affective learning of students was investigated under three different quality of instruction conditions: conventional group instruction, mastery learning, and tutoring. The studies

also examine whether qualities of instruction which are adaptive to individual learning needs alter the relation between initial student characteristics (i.e., aptitude and prior achievement) and the subsequent achievement students attain.

In addition, the studies are concerned with the following related issues: (a) Will students who learn under different quality of instruction conditions exhibit differences in the extent to which they actively engage in learning? (b) Are the interests and attitudes which students develop toward learning a reflection of the way they perceive themselves as learners? Can these interests and attitudes be altered by more effective instructional conditions? Each of these questions was explored by examining the learning outcomes and learning processes of students under the three different quality of instruction conditions.

There is abundant evidence that under conventional group instruction the degree of academic success which a student will attain is largely predictable on the basis of personal characteristics and home background. This phenomenon has been well documented in schools around the world (Walker, 1976; Wolf, 1977). The relationship between student characteristics and school achievement has been used to support a variety of positions. The recent report of the Carnegie Council on Children (deLone, 1979), for example, accepts the relationship as an inevitability of the existing social system and recommends sweeping changes in social and economic structures. Such political interpretations neglect findings which have shown this phenomenon in countries with extreme philosophical, political, and cultural differences. They also direct attention away from the teaching-learning process by implying that solutions to the inequities in learning outcomes lie outside the domain of schools and educators.

Although educational resources and curricula vary among schools around the world, there is considerable uniformity in the instructional practices of schools. Schools traditionally assign students to groups averaging from 20 to 40 for instruction, and most or all of the instruction received by students during the school term occurs within the group. Schools also designate periods of time for instruction and at the end of the allotted time, test the students to determine their rank on the basis of academic achievement. There is no procedure in this system of instruction for ensuring that students gain the cognitive prerequisites they need to successfully deal with subsequent learning tasks. What results at the end of the instructional period is a normal distribution of achievement, with students' positions within the distribution largely determined by the cognitive and affective characteristics they possessed when they entered the instruction.

Since the effects of prior student characteristics on subsequent achievement are not unique to one social or economic system, it seems essential to examine student achievement under conditions more favorable than what is normally provided before concluding that solutions are beyond the context of schools. Theoretically, instructional processes can be altered to reduce the effects of prior student characteristics on subsequent achievement.

The relationship between achievement and students' prior characteristics might be accepted as inevitable were it not for the accumulating evidence that the relationship is not maintained when instruction is qualitatively different from what is available under conventional instruction. The work of Bloom and others with mastery learning strategies has been primarily responsible for redirecting the concern of educational research away from stable student characteristics and toward alterable

variables within schools. Bloom (1978) has concluded that the differences we observe in students' learning and school achievement are manmade, rather than innate and that "What any person in the world can learn, almost all persons can learn if provided with appropriate prior and current conditions of learning." This conclusion presupposes the possibility of instructional conditions under which almost all students would achieve equally high levels of learning, regardless of variations in the prior characteristics of the students.

Mastery learning studies have already established instructional conditions that enable 80 percent of the students to attain the same criterion for receiving a grade of A, a level achieved by only 20 percent of the students who receive conventional instruction. It seems essential now to explore the upper boundaries of Bloom's (1976) theory. Theoretically, 95 percent of the student population should attain the highest levels of learning when the instructional environment approximates a maximal condition for learning. Bloom qualifies the applicability of the theory by noting that 2 to 3 percent of the school population may have extreme physical or emotional problems which limit learning and that an additional 1 to 2 percent may learn in such extremely capable ways that they, also, should be considered as exceptions to the theory. Before considering the components of a learning environment which would enable 95 percent to excel, it is important to consider the components of an instructional environment which enables 80 percent to excel.

Mastery learning strategies enhance conventional instruction. Students, who do not meet the criterion for achievement after the initial group-based instruction, are provided with alternative cues, additional opportunities for reinforcement and participation in learning, and pertinent feedback and correctives. This enhanced group instruction enables

most of the students to enter each new phase of study with a mastery of the prerequisites for the new learning task. However, even under these conditions about 20 percent remain who should have, but did not achieve the highest levels of learning.

In both conventional and mastery learning classes, initial instruction occurs in a group. Regardless of the teacher's skills, the cues and reinforcement supplied during group instruction are directed to some students more than others and are more appropriate for some students than others. In group situations, some students participate more actively than others. Although mastery learning strategies are designed to overcome these problems, there is a delay between initial instruction and the needed adjustments in cues, reinforcement, and participation and in feedback and correctives. Since 80 percent reach mastery levels under these strategies, apparently most students are not adversely affected by the delays, but it is possible that the delays inhibit the learning of approximately 20 percent of the students. Is it possible that if the delays were eliminated, 95 percent would reach the highest criterion for achievement?

Tutoring has the potential to provide a maximal learning environment. Unlike group-based conditions, tutoring focuses on the learning needs of an individual during the initial presentation of a task. If the student lacks prerequisite cognitive entry behaviors, the tutor can immediately adjust instruction and assist the student in attaining the needed knowledge and skills before proceeding with the new task. When the student's response indicates misunderstandings or confusion, more appropriate cues and additional practice can be provided at once. An effective tutor also supplies the kinds of reinforcements that are appropriate to the individual and which serve to maintain the individual's active involvement in learning.

The constant interchange between student and tutor assures high levels of participation in learning for the student, and the immediacy of adjustments in the initial instruction constitute an informal system of feedback and correctives not possible under group instruction. When the learning environment described here as a potential of tutoring is further enhanced by periodic formative tests and additional correctives so that the student maintains a consistently high criterion for performance on each learning task, it is argued that a maximal quality of instruction exists. Under this condition, there should be little relation between the prior characteristics of students and the achievement they attain, and all but the most extreme portions of the student population should attain the highest level of achievement.

If a learning environment can enable 95 percent of the students to attain the highest achievement, then the responsibility for academic failure can no longer be attributed to stable, unalterable variables. The studies persented here attempted to create a maximal learning environment, without regard for existing practices or resources available to schools. The results of these studies can serve as a "yardstick" against which the learning outcomes of other, more constrained and practical instructional conditions could be measured.

The central question which the studies investigated is: Are the cognitive and affective outcomes students attain a function of the quality of the instruction they are given? Three experimental studies were undertaken, using two different content areas and three different grade levels, in order to examine this question and the related questions posed previously. The learning outcomes and learning processes of students were examined under the three qualities of instruction which have been discussed: (a) conventional instruction, a minimal quality of instruction, (b) mastery

learning, a more favorable quality of instruction, and (c) tutoring, a maximal quality of instruction. Probability was taught during the first study to fourth and fifth grade students, and cartography, during the second study to eighth grade students. It was expected that the effects of learning under the different qualities of instruction would be similar in the two content areas as well as in the three grade levels.

CHAPTER II

REVIEW OF RELATED RESEARCH

The review summarizes the theoretical and empirical literature relevant to the conceptual orientation of the studies. In the first section, definitions of quality of instruction are introduced, and the relation between individual components of quality of instruction and learning outcomes is examined. Studies of time-on-task and the relation between prior student characteristics and achievement are also discussed. The second section reviews the uses and effects of tutoring. The final section examines studies of the relation between affect and achievement and the development of perception of achievement.

Quality of Instruction

Carroll (1963) refers to quality of instruction as the most elusive element in his model of school learning. Carroll includes the characteristics of teaching materials in addition to teacher performance in discussing quality of instruction, but he defines the term as a series of instructional behaviors:

> The learner must be told, in words that he can understand, what he is to learn and how he is to learn it. It means that the learner must be put into adequate sensory contact with the material to be learned. . . . that the various aspects of the learning task must be presented in such an order and with such detail that, as far as possible, every step of the learning is adequately prepared for by a previous step. . . . that the instruction must be adapted for the special needs and characteristics of the learner, including his stage of learning [p. 726].

Quality of instruction is concerned with organizing and presenting the learning task so that it can be learned as efficiently as possible,

considering the student's ability to understand instruction. In Carroll's view, students who receive a less than optimal quality of instruction are likely to need more time for learning than they would otherwise require.

In contrast to the concept of quality of instruction as consisting primarily of the teacher's instructional behaviors, Bloom (1976) conceives of it as the interactions between teacher and student during instruction. This view developed from Bloom's inferences concerning the quality of instruction available when an excellent tutor instructs a single student. His explanations of the teaching-learning behaviors in tutoring are based on learning theories, most notably the work of Dollard and Miller (1950). Stated briefly, Bloom defines quality of instruction as:

> the cues or directions provided to the learner, the participation of the learner in learning activity (covert or overt), and the reinforcement which the learner secures in some relation to the learning. Because much of school instruction is group instruction and because any attempt at group instruction is fraught with error and difficulty, a feedback and corrective system must be also included [1976, p. 115].

Bloom's inferences about effective tutoring dyads identify the interactions which occur when instruction is geared to the needs of an individual student. Tutoring is potentially capable of providing a learning environment which maximizes each component of quality of instruction. The work of S. Bloom (1976) was central in making clear how these components of quality of instruction differ under tutoring and group instruction.

In Bloom's theory of school learning, quality of instruction is one of three major variables which determine learning outcomes and is sufficiently powerful that it is capable of effecting changes in the other two variables, cognitive entry behavior and effective entry characteristics. The results of mastery learning studies, which will be discussed later in

the review, reveal that quality of instruction not only affects learning outcomes, but also affects learning processes.

Because this research is concerned with the effects of differing quality of instruction conditions, it is important to examine the relation of each component to learning outcomes. In the following portion of the review, each component is briefly discussed, and the research pertaining to each is summarized.

Components of Quality of Instruction

Most of the research on components other than feedback-correctives is based on observer codings or ratings of the extent to which the component is present. Although Bloom's (1976) emphasis in describing quality of instruction is on the availability and appropriateness of each component to the needs of the individual learner, much of the research on the components is concerned with the effects on groups of students.

Cues

Carroll's (1963) definition of quality of instruction deals primarily with what Dollard and Miller (1950) term cues. Cues refer to communications of what is to be learned and how the learner should proceed (Bloom, 1976). Communication may occur through verbal or non-verbal means and may emanate from either the teacher or the instructional materials. Cues given during group instruction possess different degrees of meaningfulness to individual learners, depending on the individual's prior familiarity with the cues and ability to learn from the cues in the form they are presented. Cues also differ in the extent to which they gain and hold the attention of the learner. According to Dollard and Miller, cues determine when and where an individual responds and which response is made.

Although Bloom's concern is with the salience of cues to individual learners, studies, which share Bloom's definition of cues, examine the relation between the quality of cues and the achievement of groups of students. The results of these studies have been summarized (Bloom, 1976), and the median correlation between quality of cues and final achievement was found to be +.38. The median correlation for quality of cues and achievement gains was +.53. Based on the existing research, Bloom estimates that quality of cues accounts for about 14 percent of the variance in achievement of groups of students.

Only one of the studies included in Bloom's summary used both observer and student ratings of cues. In Solomon, Rosenberg, and Bezdek's (1964) study, the correlations between achievement gain and the quality of cues as determined by the observers and students is +.58.

In Nordin's (1979) study, which will be discussed in detail later in the review, students who received enhanced cues attained significantly higher levels of achievement and positive affect toward learning than did students in the control group. Although limited in number and in scope, the research clearly indicates the importance of cues in influencing learning outcomes.

Participation

Individuals differ in their ability to benefit from specific cues, and they also differ in the amount and kind of participation needed to succeed in learning (Bloom, 1976). Participation refers to an active involvement in learning and includes both overt and covert behaviors.

Teachers have traditionally used a variety of methods to involve students in learning. They attempt to assure overt and covert participation by posing problems or questions for the class and requesting

responses from individual students. Teachers also give assignments which require students to practice some aspect of a task in class and again later as homework. Dividing the class into small groups is another common device teachers use to encourage the individual's active engagement in a learning task. However, it is often difficult for the teacher to provide the right amount and kind of participation each student needs because of the large variations in cognitive and affective entry behaviors which exist among most groups of students.

Researchers and theorists use a variety of terms to indicate that the learned must be actively engaged in the task before learning can occur. For example, Dollard and Miller (1950) and most S-R theorists label this component response (Hilgard & Bower, 1966). In Carroll's (1963) model, the term most compatible with participation is perserverance-in-learning.

Large variations in percent of time-on-task, a measure of student participation in learning, have been reported for students in conventional instruction groups, regardless of age, grade level, or subject area (Bennett, 1978). Bennett refers to studies in which the active participation of students within the same classroom ranged from 20 to 100 percent.

The relation between participation and achievement has been the subject of research for about 50 years--the first study located was conducted by Olson (1931)--and a variety of methods has been used to measure each of the variables. Hoge and Luce's (1979) review of research from 1965 to 1977 concludes that only a moderate relation exists between observed task behaviors and achievement. However, others have pointed out that the strength of the relation reported by studies seems to depend on the length of the study and how time-on-task and achievement are measured (Anderson & Scott, 1978; O'Brien & Ginsburg, 1980). Anderson and Scott find that longer

studies and studies measuring achievement with standardized tests report lower correlations, but shorter studies and studies using domain or criterion referenced tests report higher correlations. O'Brien and Ginsberg note that higher correlations are more often found when time-on-task is measured as both overt and covert behaviors.

The effects of participation on individual achievement have received considerable attention, unlike the effects of other components of quality of instruction. Bloom (1976) summarizes the findings of twenty studies of the relation between participation and final achievement and reports that the median correlation for groups of students is +.28. When the individual is the unit of study, the median correlation increases to +.42. The correlation between participation and achievement gains is +.28 when the group is the unit of study and +.58 when the individual is the unit of study. On the basis of these results, Bloom proposes that participation accounts for about 20 percent of the variation in the achievement of individuals.

Quality of instruction and time on task. Anderson (1973) examined the relation between percent of time-on-task and quality of instruction, comparing the involvement in learning of students in mastery learning and conventional classes. Anderson used both overt and covert measures of TOT. During the initial learning task, TOT was similar for both mastery and conventional groups (74 and 76 percent). However, differences between the groups appeared during the second task, where mastery students spent 79 percent TOT and control students, 65 percent. By the third task, the groups were even further apart; mastery students were on-task 83 percent of the time and control students, 63 percent. Anderson reports correlations between active engagement in learning and quality of instruction

as -.08 during the first task, +.36 during the second, and +.50 during the third.

Hecht (1977) also examined TOT under different quality of instruction conditions and reported findings similar to Anderson's. Mastery students steadily increased in TOT. On the first learning task, mastery students had a TOT of 72 percent; this increased to 77 percent on the second task and to 82 percent on the final task. However, TOT for control students remained at 74 percent throughout the study. Hecht reports a correlation of +.73 between TOT and final achievement. Earlier, Anderson reported a correlation of +.75 between the two measures. Both the Hecht (1977) and the Anderson (1973) studies occurred over relatively brief periods of time, measured TOT as overt and covert behaviors, and measured achievement with criterion-referenced, subject-specific tests.

Anderson (1973) also studied the extent to which students' cognitive entry behaviors were related to their active participation in learning. He reports a mean of 82 percent TOT for students with high cognitive entry behaviors, a mean of 75 percent for students with moderate levels of entry behaviors, and a mean of 60 percent for students with low cognitive entry behaviors. This is similar to the findings of a related study of Good and Beckerman (1978). Good and Beckerman proposed that the amount of time a student spends actively engaged in learning is related to the level of achievement the student has previously attained. They found high-achieving students averaged 76 percent TOT, in contrast to low-achieving students who averaged 64 percent. Good and Beckerman observed students in conventional instruction conditions. Anderson studied TOT under conventional conditions and under experimental conditions which were designed to alter students' cognitive entry behaviors.

Bloom (1974) summarized the results of studies comparing time-on-task in mastery learning and control classes. In control groups, students spend about 50 percent of their time actively learning, but under mastery conditions, where approximately 80 percent of the students attain high levels of achievement, TOT increases to about 85 percent. Block and Burns (1977) suggest that this phenomenon is due to a "homogenizing effect" which mastery learning strategies produce on the time students spend in learning, increasing the level and reducing variability in active involvement in learning.

Harnischfeger and Wiley (1975) contend that the most important determiner of achievement is the level of active learning engaged in by the student. Bloom's position differs. Bloom views active participation in learning as the best indicator of the quality of instruction students receive. In his framework, the quality of instruction influences the cognitive entry behavior and affective entry characteristics, as well as the extent of active involvement in learning, and these in turn influence the level of achievement the student attains.

Reinforcement

Dollard and Miller (1950) define reinforcement as "any specified event . . . that strengthens the tendency for a response to be repeated" (p. 39). Reinforcement for learning may be provided by a variety of sources (i.e., self, teacher, or significant others) and may assume a variety of modes (i.e., tangible rewards, verbal approval, or social acceptance by peers). Dunkin and Biddle (1974) report the research indicates that a variety of reinforcements have been found effective in changing or maintaining student behavior. Whatever the source or mode of reinforcement, learning theories generally agree that the learner

must be able to secure some reward if the learning is to be successful (Hilgard & Bower, 1966). What serves as a reward and an effective reinforcement for one student will not necessarily be effective for another.

Bloom (1976) summarized the results of studies concerned with the relation between teacher reinforcement for learning and the final achievement of groups of students. The median correlation was found to be +.26. The median correlation between reinforcement and achievement gains for groups was found to be +.24. From these studies, Bloom estimates that the quality of reinforcement accounts for about 6 percent of the variation in achievement for groups of students.

Although little is presently known about the effects of reinforcements on the learning of individual students, there is evidence that individuals within a class receive different amounts of positive and negative reinforcement. Brophy and Good (1970) found that teachers praised high-achieving students for their correct responses about 12 percent of the time, but the correct responses of low-achieving students were praised only 6 percent of the time. When incorrect responses were given by low-achieving students, they received teacher criticism 18 percent of the time. However, incorrect responses by high-achieving students were criticized only 6 percent of the time. These findings indicate that the amount and kind of reinforcement available to learners may depend on the level of achievement they attain.

Feedback and correctives

Feedback is the information the student receives about the extent of the learning which has occurred up to a particular point in the instruction, and correctives refer to the additional instruction which the student receives on elements of the task which are not yet mastered

Bloom, 1976). Although the term feedback/correctives is closely identified with mastery learning strategies, Broudy's (1963) discussion of historic exemplars of teaching method reveals that "practice trials" were incorporated in the various methodologies to allow for the correction of errors in learning prior to a final evaluation. The "practice trials" served much the same function as the formative tests of mastery learning, providing diagnostic feedback to be used as the basis for additional, adjusted instruction. There is a renewed concern evident in the literature on the importance of supplying feedback frequently during instruction (i.e., Kulhavy, 1977) and on the necessity of accompanying the feedback with clear instructions about what the student should do in order to correct insufficient learning (i.e., McKeachie, 1974).

The attention to feedback and correctives may be an outgrowth of the widely disseminated findings of mastery learning studies, where quality of instruction is usually defined as the presence versus the absence of feedback/correctives. In these studies, feedback is operationalized as a series of brief, formative tests administered at appropriate points in a learning unit. Correctives consist of alternative cues, additional time and practice, and reinforcement which is provided in tutorials or small group instruction. Block and Burns's (1977) analysis of 97 studies comparing the achievement of mastery and conventional groups concludes that mastery groups attain higher levels of achievement 89 percent of the time and have about 52 percent less variance in achievement than conventional instruction groups.

Criterion levels. In mastery learning studies, students in the mastery group are required to maintain an absolute performance level on formative tests, and are given the assistance needed to meet the criterion. The maintenance of a high criterion for learning is a means of assuring

that students attain the necessary cognitive entry behaviors for succeeding with the next learning task. Usually, the criterion is set at 80 percent. Block (1970) attempted to determine whether a single criterion level could maximize both cognitive and affective learning. Block found that requiring a 95 percent criterion on formative tests resulted in the highest level of summative achievement, but it also resulted in a marked decrease in interest and attitude among students. An 85 percent criterion resulted in lower levels of summative achievement, but the highest level of positive affect. In concluding that no one criterion maximized both kinds of learning, Block recommended using an 85 percent criterion. However, it is possible that cognitive and affective learning could be maximized at a higher level if the quality of the instruction students received during their initial instruction were enhanced and feedback/correctives were available.

Enhanced components

As previously noted, most mastery learning studies define quality of instruction in terms of the absence or presence of feedback-correctives and do not attempt to enhance the other components of quality of instruction during the initial instruction. Enhancement of cues, participation, and reinforcement is expected to occur during the corrective process as students are given adjusted, more appropriate cues, additional opportunities to participate, and more pertinent reinforcements.

Nordin's (1979) study is the first attempt to examine and compare the effects of enhancing components during the initial, group instruction. Nordin studied achievement, time-on-task, and affect under each of the following conditions: cue enhancement, participation enhancement, cue + participation enhancement, and feedback/correctives. Teachers assigned to

each of the enhanced conditions received training, and the effectiveness of the enhancements was judged by students and observers. Students in the feedback/corrective condition received group instruction similar to what was provided to the control, but they were held to an 80 percent criterion on the formative tests and were given the additional time and instruction they needed to meet the criterion.

Nordin found that enhancing any of the components, either singly or in conjunction with another component, or providing feedback/correctives results in significantly higher levels of summative achievement, total time-on-task, and positive affect than occurs for students receiving conventional instruction. The differences between the experimental and control groups for each of the variables were significant at the .001 level. Nordin also reports that the mean levels of summative achievement, affect, and time-on-task for the feedback/corrective groups were significantly higher at the .001 level than the means for each of the other three experimental groups.

Quality of instruction and prior characteristics. Under conventional learning conditions, intelligence and aptitude scores have been found to be highly predictive of achievement, with correlations between intelligence and achievement or between aptitude and achievement ranging from about +.50 to +.70 (Bloom, 1980; Thorndike & Hagen, 1961). Nordin found that the relation between intelligence and summative achievement was less strong for each of his experimental groups than for the control, but it was significantly different from the control only for the feedback/corrective group. The correlation between intelligence and summative achievement was +.35 for the feedback/corrective group, in comparison to +.67 for the control.

The student's prior achievement in a subject has long been recognized as a strong predictor of the subsequent achievement the student will attain. Bloom's (1976) summary of longitudinal studies reveals a correlation between achievement at grade 3 and achievement at grade 12 of about +.70. Achievement during adjacent years of school is correlated about +.90. Aiken (1970, 1976) summarized studies of achievement in mathematics and found that prior achievement in high school mathematics is the strongest predictor of achievement in college mathematics.

Froemel (1980) investigated the relation between subsequent achievement and different kinds of cognitive entry behaviors, including intelligence and prior achievement. Froemel found an average correlation between intelligence and achievement of +.45 for students receiving conventional instruction. This relation remained unchanged during the six month period of his study. However, for students receiving mastery learning, the initial correlation of +.46 between intelligence and achievement decreased to +.21, and finally to +.11 during the course of the study. Froemel also reports that the average correlation between prior achievement and subsequent achievement during the third month and the sixth month remained at about +.75 for the conventional instruction groups. However, the average correlation between prior achievement and subsequent achievement for mastery learning groups was +.39 during the third month, and it decreased to +.21 during the sixth month.

The results of Froemel's study reveal stronger correlations between prior achievement and subsequent achievement than between intelligence and subsequent achievement. However, the most important finding of the study is that the relation between prior student characteristics and achievement is sharply reduced when students receive the more favorable quality of instruction provided by mastery learning.

In the past, the strong correlations between intelligence and achievement and between prior and subsequent achievement have been interpreted as evidence that some students are capable of learning well while others are not. Research is finding increasing evidence from mastery learning studies that providing feedback/correctives results in a diminishing of the effects of intelligence and prior achievement on subsequent achievement (Block & Burns, 1977; Bloom, 1980; Froemel, 1980). Nordin's (1979) study makes two major contributions to an understanding of the potential effects of quality of instruction: (a) an improvement in the qualities of even one component diminishes the effects of prior student characteristics on learning outcomes, and (b) the feedback/corrective component is the single most influential component in diminishing the effects of prior characteristics on achievement.

In summary, the literature on individual components of quality of instruction demonstrates the effects of each on the achievement students attain. It has also been shown that each component accounts in some measure for the variation found in achievement for groups of students. Bloom (1976) finds that at least 20 percent of the variation in student achievement can be accounted for by the qualities of cues, participation and reinforcement; 25 percent of the variation can be accounted for when feedback/correctives are provided. He estimates that at least one-fourth of the variance in student achievement can be accounted for by quality of instruction.

Until the present studies, the limits of the effects of quality of instruction remained theoretical because no research had studied learning outcomes or learning processes when all components of quality of instruction are adapted to the needs of individuals. The studies reported here attempted to provide individual students with a maximal quality of

instruction and to examine the effects on achievement and learning processes. The extent to which a maximal quality of instruction effects the relation between prior student characteristics and learning outcomes was also investigated.

Tutoring

Examples of the uses of tutoring can be found in circumstances as diverse as the training of an Olympic athlete, the instruction which a seasoned factory worker gives a new co-worker about operating a piece of complex machinery, the meetings between a dissertation chairman and a doctoral student and the historic relationship of a journeyman to an apprentice. In the larger society, tutoring is often used when a high level of learning or performance is desired. For example, opera singers maintain voice coaches (i.e., tutors) throughout their careers.

Unlike the larger society, schools use tutoring almost exclusively for remediation. Most studies of tutoring compare the effects on reading or math achievement of supplementing classroom instruction with remedial tutoring versus classroom instruction, only (e.g., Ellson, Harris, & Barber, 1968). In these studies, the actual effects of tutoring are difficult to determine because the tutoring expands the instructional time available to one group of students, confounding tutoring with time for learning (Devin-Sheehan, Feldman, & Allen, 1976). For example, the study by Ellson et al. (1968) is often cited as support for the effectiveness of programmed tutoring, but the tutoring resulted in significantly higher achievement only when students participated in two sessions daily, increasing the total instruction time by 30 minutes per day. The achievement of students receiving only one daily session of programmed tutoring was not significantly higher than the control. There are also studies in

which individual or small group tutorials periodically replace regular classroom instruction (e.g., Bernstein, 1979). While the instructional time available to the tutoring group is not expanded in these studies, the tutoring is usually intended to remediate some aspects of the tutees' reading performance.

Studies, which are obstensibly focused on the relation between tutoring and student achievement, are often concerned more directly with a comparison of teaching methods. An extreme example of this kind of comparison can be found in Scudder's (1979) study of two intact programs for teaching English as a foreign language. In one program, students received group instruction from trained, experienced teachers who used a diagnostic/prescriptive approach. In the other, students received individual tutorials from paraprofessionals who were not trained and did not use a diagnostic/prescriptive approach. Although Scudder views the results of the study as indicating that diagnostic/prescriptive group instruction is more effective than individual tutoring, what the results seem to indicate is the importance of training teachers to diagnose student learning and to adapt instruction to the needs of individuals.

In addition to focusing on remediation and teaching methods, tutoring studies are frequently concerned with the results of children teaching children and are often attempts to effect cognitive and affective gains on the part of both members of the tutoring dyad (e.g., Cloward, 1967; Agris, 1979). The experimental work of Allen and his colleagues at the Wisconsin Research and Design Center for Cognitive Learning is an exception to the general trend in tutoring studies. Many of these studies focus on the interpersonal interactions or consequences of peer and cross-age tutoring (e.g., Allen & Feldman, 1974; Allen &

Devin-Sheehan, 1974). None of the studies have examined the quality of instruction available in tutorials.

Few experimental studies of tutoring were found to be related to the concerns of this proposal. However, two studies are of particular interest (i.e., Bausell, Moody & Walzl, 1972; Klosterman, 1970). Unlike the majority of tutoring studies, subjects in the Klosterman (1970) and Bausell et al. (1972) studies were randomly assigned to experimental and control groups and were not preselected for the studies because of academic, social, or physical problems. In both studies, the tutoring is non-remedial and is used as a substitute for group instruction, rather than a supplement to it. Both studies also control for the total instructional time students in experimental and control groups receive.

Bausell, Moody, and Walzl (1972) studied whether tutoring results in higher achievement than classroom instruction. The tutees were fourth and fifth grade students. College education majors served as classroom teachers and as tutors. Half of the college students were seniors who had completed student teaching, and the other half were sophomores with no training in methodology and no experience in teaching. The college students were given a set of instructional objectives accompanied by examples and mathematical discussions for a unit on exponential notation, a topic which the elementary students had not previously studied. Because the study introduced students to a new academic topic, the influence of prior achievement on learning during the experiment was diminished to some extent.

The college students were not instructed in methods or techniques for teaching the unit. Each taught the unit to a classroom of elementary students, and also individually tutored a different group of elementary

students. The tutoring group scored significantly higher at the .05 level on a test measuring achievement of the objectives than did the control. Differences in achievement were not related to the experience or training of the college students.

The significantly higher level of achievement attained by the tutored group in the Bausell et al. study is especially interesting in view of the brevity of the experiment. The elementary students received only 30 minutes total instructional time before being tested. Unfortunately, the study did not attempt to identify the teaching behaviors or interactions in the tutoring dyads which might explain the success of tutoring. As the researchers point out, the study was designed to "definitively" demonstrate the superiority of tutoring to group instruction, not to explain the phenomenon.

Klosterman (1970) also used college students as tutors for elementary students. The tutors were enrolled in a reading methods course and given a month's training in using a diagnostically structured reading program before the study began. The reading program emphasized planning instruction on the basis of standardized diagnostic test results, and ongoing diagnosis was stressed during the treatment period. Fourth graders in three schools were randomly assigned to individual tutoring, small group tutoring, or conventional instruction (the control).

At the conclusion of the six-month long study, students who received either individual or small group tutoring scored significantly higher at the .05 level than did students in the control groups. There were no significant differences in achievement between students who were tutored individually and the students tutored in small groups.

Klosterman, like Bausell et al. (1973), did not monitor or examine the teaching-learning interactions of the tutoring groups. The

study does not attempt to explain why small group and individual tutoring were equally effective. However, the significant differences between the tutored groups and the control groups suggest that the higher levels of achievement exhibited by the tutored students result from the diagnostically structured approach they were given. That is, the study does not provide evidence that tutoring per se enables students to attain greater achievement, but rather that the emphasis in the tutoring groups on diagnosis and adaptation of instruction to the learning needs of individuals provided the experimental groups with a feedback-corrective procedure which was absent from the control. A similar reservation was forwarded earlier about Scudder's (1979) conclusions.

Tutoring and class size

Tutoring essentially reduces class size, in most instances to a pupil-teacher ratio of 1:1. The same general insignificant and mixed findings which occur in the literature on tutoring prevail in the literature on class size. However, recent investigations, which include the analysis of data from previously untapped sources (Walberg & Rasher, 1974) and the re-analysis of existing data on class size (Lindsey, 1974; Glass & Smith, 1979) report more consistent evidence of the effects of class size on achievement than had been previously recognized.

Walberg and Rasher (1974) examined the relation between Selective Service tests scores of United States males during 1969-1970 and specific educational resources, among them pupil-teacher ratio. They report that lower pupil-teacher ratios are significantly related at the .01 level to lower rates of failure on the tests.

Lindsey (1974) reanalyzed data from the IEA mathematics study (Husen, 1967) and found there were no instances in which the highest levels

of mean achievement were associated with larger class sizes. According to Lindsey's analysis, as class size increases in United States schools, there is a distinct drop in achievement for all except those receiving the largest number of hours of instruction in mathematics.

Glass and Smith's (1979) meta-analysis of data from studies conducted between 1900 and 1979 is probably the most ambitious, and probably controversial, work on class size. Their analysis indicates that a sharp increase in achievement level occurs in class sizes of five or less. Elsewhere, Glass (1979) states that a typical student taught in a class of 30 to 40 students will score at the fiftieth percentile on an achievement test, but if the class size is reduced to 15 the student scores at the sixtieth percentile. He further proposes that the student would score in the seventy-fifth percentile if class size were decreased to five and in the eightieth percentile if taught individually. Although Simpson (1980) criticizes Glass and Smith's (1979) conclusions, he suggests that an analysis of a few of the well-controlled studies they used would support a more general conclusion--that is, students taught in groups less than 10 attain higher achievement than do students taught in groups larger than 20.

Although Glass and Smith's conclusions will doubtlessly continue to be disputed, their findings, considered along with those of Walberg and Rasher (1974), Lindsey (1974), and the tutoring study by Bausell et al. (1972), reveal an unmistakable trend--smaller class sizes are related to higher achievement. Unfortunately, studies of tutoring and class size provide, at best, limited information about the quality of instruction students receive. Shapson, Wright, Eason, and Fitzgerald (1980) report their study of class sizes ranging from 16 to 37 found there were "virtually no changes in methods of instruction" related to class size. Even

in the class size of 16, instruction was geared almost entirely to the group, rather than to individuals.

The few studies which have used tutoring as a substitute for group instruction have shown significantly higher achievement for the tutored students in comparison with the group instructed students. In general, smaller teacher-pupil ratios are associated with higher levels of student achievement. Although Klosterman's (1970) use of on-going diagnosis in the tutoring groups may be comparable to the feedback/corrective component discussed earlier, no studies surveyed used the systematic feedback/correctives and criterion levels found in mastery learning studies. There were also no studies which attempt to enhance other components of quality of instruction, or even to observe the quality of the instruction provided in tutoring or class sizes of five or less.

In the research reported here, tutoring was used to provide a maximal quality of instruction for individual students. Feedback/correctives were systematically provided, and an attempt was made to enhance each of the other components of quality of instruction. The tutorials were monitored in an effort to assure that a maximal quality of instruction was maintained throughout the studies.

Affect and Achievement

This section of the review is concerned with the relation between achievement and two dimensions of affect--attitude and interest. Most studies do not attempt to establish causality, but rather to determine the strength of the association between measures of achievement and measures of affect. Generally, studies which report that achievement can be predicted from measures of affect have examined the relation for older students and concentrate on interest and achievement for a specific

subject area (e.g., Lehrer & Hieronymus, 1977; Gilkey, 1978). An alternative explanation for the predictive relation will be discussed further on in this section.

A wide variety of approaches has been used to measure both general school and subject-specific affect. Studies which measure affect as an overall satisfaction with school tend to report the relation between affect and achievement is statistically insignificant (Jackson, 1968). Studies using a subject-specific rather than a global measure of affect tend to report stronger relations (e.g., Neale, 1969), although not always (e.g., Gable, Roberts, & Owen, 1977). In some instances only one dimension of affect is found to be significantly related to achievement. The IEA study of mathematics achievement (Husen, 1967) found that the correlations between interest and achievement were positive and statistically significant at each level of instruction. Correlations between attitude and achievement, although positive, were small and statistically insignificant.

Often studies which report significant relationships also report mixed findings. For example, Neale, Gill, and Tismer (1970) report different findings for sixth-grade males and females. For males, subject-specific measures of attitude and achievement in social studies, arithmetic, and reading were significant at the .01 level and in science, at the .05 level. Correlations ranged from +.15 for science to +.32 for reading. For females, the only significant relation between attitude and achievement was in reading, and the correlation here decreased from +.35 on the pretest to +.20 on the posttest.

Bloom's (1976) summary of IEA and other studies examining the relation between subject-specific affect and achievement reveals that correlations between the two variables are lowest during the early elementary

school years and highest during the later years of junior and senior high school. The correlations generally range from +.20 to +.40, indicating that affect toward a subject may account for 4 to 17 percent of the variation in achievement. While the studies do not indicate direction of causality, they do provide evidence that students' affect and achievement become more closely related as students progress through school.

Quality of instruction and affect

During the past decade a number of studies have examined the relation between affect and achievement under the higher quality of instruction provided by mastery learning and under conventional instruction. These studies have been summarized by Bloom (1976) and by Block and Burns (1977). Bloom notes that when the content taught during the studies is relatively unrelated to the previous learning of the students the median correlation between interest at the beginning of a series of learning tasks and summative achievement is about +.06, but the correlation between interest measured at the completion of a series of learning tasks and summative achievement is about +.31. This is a large increase in the relation between affect and achievement, considering that the studies occurred over relatively brief periods of from 1 week to 3 months. In discussing how these changes in the relation could occur, Bloom points out that the median correlation for interest at the beginning of a task and achievement at the completion of the task is +.30 and that the median correlation between achievement at the completion of a task and interest in the subsequent task is also +.30. These correlations are very different from the +.06 found for initial interest and summative achievement, but basically the same as the correlation for final interest and summative achievement. The findings suggest that prior achievement influences

affect, an opposing conclusion about the direction of causality proposed by Lehrer and Hieronymus (1977) and Gilkey (1978), who contend that affect influences achievement.

The mastery learning studies included in the Bloom (1976) and Block and Burns (1977) summaries enhanced the quality of instruction students received by providing feedback/correctives. Both summaries report that students receiving feedback/correctives exhibit higher levels of positive affect than is found for students in conventional instruction.

Nordin (1979) found that students in each of the experimental treatments, which enhanced the quality of instruction, exhibited significantly higher levels of positive affect than the control on all three affective measures used in the study. At the completion of the first learning task, the difference in measured affect between control and the enhanced cue and feedback/corrective groups was significant at the .001 level. This level of significance was maintained on each of the remaining affective measures. The difference between control and the enhanced participation and enhanced cue + participation groups was significant at the .05 level on the first affective measure; however, the difference was significant at the .001 level for successive affective measures.

The results of mastery learning studies (i.e., Arlin, 1973; Anderson, 1973; Block, 1970) and of Nordin's (1979) study indicate that the quality of instruction students receive influences the affect they develop toward learning. There are, however, no studies which examine the development of affect when all components of quality of instruction are maximal.

Perception of achievement

One explanation for the lack of consistency in the findings of most studies of the relation between affect and achievement may be that

there is an additional variable which is not usually accounted for in the studies. Bloom (1971) posits a causal relationship between the student's perception of the adequacy or inadequacy of the achievement which has been attained for a specific learning task and the affect the student develops toward that task. He reasons that as students receive accumulating evidence of their success in learning a task they develop more positive attitudes toward the task and greater interest in pursuing similar tasks. The effects of an accumulation of unsuccessful learning experiences would result in the opposite effect. Kifer's (1973) research on the affective characteristics of students who have consistent patterns of high academic success or low academic success provides strong evidence that affective characteristics develop as a response to an accumulated history of success or failure in learning.

Although Uguroglu and Walberg's (1979) synthesis of correlations for motivation and achievement is not concerned with determining causality, it does report a higher correlation for self-concept and achievement than for the other types of motivation measures included in their summary. Uguroglu and Walberg used correlations compiled by Bloom (1976) and correlations from studies cited over a three year period (1974-1976) in Psychological Abstracts International and Reading Research Quarterly annual summaries. They found a mean correlation of +.41 for the 76 correlations reported for achievement and academic self-concept. Correlation between achievement and other measures of motivation ranged from +.29 for general self-concept to +.32 for locus of control.

Uguroglu and Walberg's synthesis does not distinguish between studies which measure achievement as standardized test scores, grade point average, or as scores on general, verbal, or non-verbal ability tests, when

reporting the mean correlation for academic self-concept and achievement. Such a distinction would have been valuable. Several studies have shown that students' perceptions of their achievement are significantly related to the grades they receive from teachers. Malpass (1953) found a significant relation between students' comments about their own school work and end-of-semester grades given by teachers. Torshen (1969) found that student achievement, as measured by the grades they received during the marking period immediately preceding the onset of the study, and their academic self-concept were correlated at +.46, a .01 level of significance. Kifer (1973) reports that the correlation between academic self-concept and teacher grades for fifth grade students was +.23 and for seventh grade students, +.50. Like Kifer, Uguroglu and Walberg also found stronger correlations between measures of motivation and achievement for students in higher grade levels.

Most studies of affect and achievement use standardized achievement test scores in examining the relation between the two variables. Bloom (1977) argues that students do not view their achievement in terms of standardized test scores or in terms of any absolute norm, but rather from comparisons with the achievement of others in their immediate learning environment.

> Subject-related affect is . . . largely a perceptual phenomenon based on the way in which students classify learning tasks and based on the judgments they make of the adequacy of their performance relative to the other students in the school or class they attend [Bloom, 1977, p. 195].

Support for this view of the evolvement of perception of achievement is provided from an unexpected source, a reanalysis of the data from a study by Brookover et al. (1967) on the relation between self-concept of academic ability and achievement. Brookover et al. found that self-concept of academic ability and grade point average were closely related

and that a change in one was accompanied by a change in the other. This was interpreted as evidence of the effects of self-concept of academic ability on achievement. Recently, Calsyn and Kenny (1977) reanalyzed Brookover's data and found higher correlations between achievement on the first measure and self-concept on the second than were found for self-concept on the first measure and achievement on the second measure. Calsyn and Kenny conclude that academic achievement influences self-concept of ability and perceived evaluation of ability by others. Scheirer and Kratu's (1979) review of the literature on self-concept and achievement reaches a similar conclusion. These reviewers point to the "overwhelmingly negative evidence" that self-concept determines achievement and suggest that a more likely explanation is that self-concept is an outcome of achievement.

The literature reveals that students learning under different quality of instruction conditions develop correspondingly different affect toward learning. Students receiving a more favorable quality of instruction (i.e., mastery learning strategies) develop more positive interest and attitude toward learning than occurs when students receive conventional instruction. The literature also suggests that students' perceptions of their achievement influence their subsequent affect.

However, the literature does not provide information about the extent to which affect is influenced by a combination of the student's achievement and perception of achievement. Nor does the literature provide information about the development of interest, attitude or perception of achievement when students receive a maximal quality of instruction. The research reported here investigated these issues.

CHAPTER III

HYPOTHESES AND METHODOLOGY

This chapter is divided into several major sections. The first focuses on the model underlying the studies and on the interrelationships between the various elements of the model. A discussion of each of the variables of concern in the studies follows, with explanations of how each was operationalized. The hypotheses are then introduced and discussed. The final section describes the design of the studies.

Model

In the model underlying these studies, instruction is viewed as intervening between individual characteristics of students, aptitude and prior achievement, and the cognitive and affective outcomes they attain. Instruction is assumed to involve a qualitative continuum which ranges from minimum to maximum, depending on the availability and appropriateness to the individual of cues, reinforcement, participation, and feedback and correctives. A wide variety of instructional conditions lie along this continuum, from instruction which consists entirely of cues to instruction which schematically enhances each of its components. Whether the instruction maintains, diminishes, or neutralizes the effects of students' prior characteristics on learning outcomes is dependent on the quality of the instruction. The direction of causality hypothesized to exist between components of the model is indicated by arrows (see Figure 1).

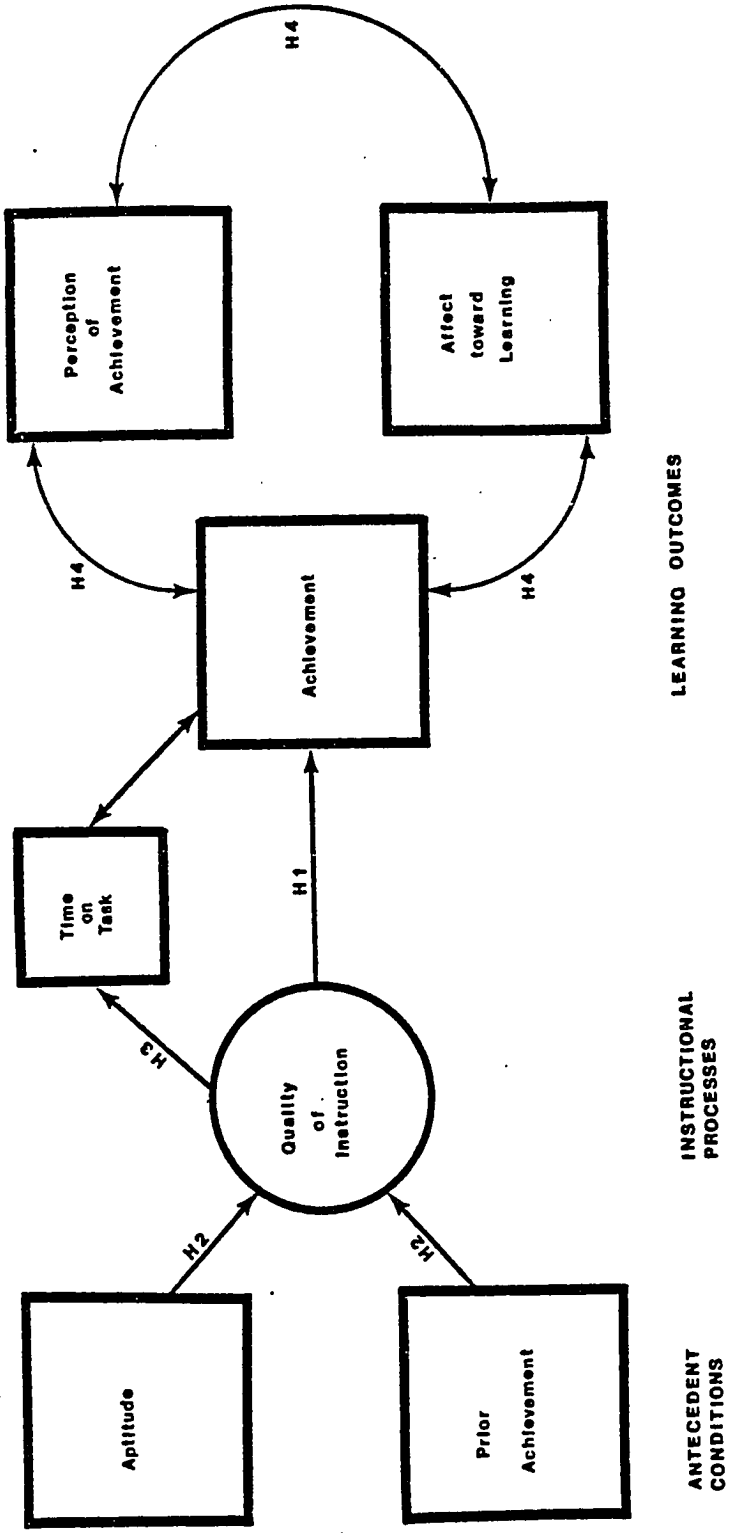

Fig. 1. Model of the Effects of Quality of Instruction

Each variable of the model is defined briefly here. Full definitions and descriptions of the instruments used in measuring each are included in the section subheaded, Variables. The variables can be summarized in the following manner:

1. Aptitude refers to an individual's ability to deal with general and abstract concepts, including the ability to interpret and use verbal and quantitative symbols and identify relationships among them. In these studies it is measured by the student's performance on the Cognitive Abilities Test, Multilevel, Form 3 (Thorndike & Hagen, 1978).

2. Prior achievement refers to the student's history of academic success or failure in the general subject areas taught during the studies and is measured by teachers' grades.

3. Quality of instruction is the extent to which cues, reinforcement, participation, and feedback-correctives are accessible and appropriate to individuals (Bloom, 1976) and the extent to which students are held to an absolute criterion level on formative tests. It is measured by the degree to which each component is present and by the students' perceptions of the quality of instruction they receive as measured by responses on questionnaires. Each of the three quality of instruction conditions (conventional, mastery learning, tutoring) used in the study are discussed in detail in the Variables section.

4. Achievement is the level of learning exhibited by students on formative tests administered at the completion of each learning task and summative test administered at the completion of the entire learning unit.

5. Time-on-task is the percent of time the student is observed to be engaged in the learning task and the percent of overt and covert

time the student reports being actively engaged in learning. Observed time-on-task is measured with a student observation scale developed by Good and Beckerman (1978). Students' self-reports of overt and covert time-on-task are obtained from questionnaires administered weekly.

6. Perception of achievement is the judgment made by students about the adequacy of the level of learning which they attain. It refers to both general school and subject-specific judgments and is measured by responses on questionnaires.

7. Affect toward learning refers to attitude and interest. Interest is the extent of the students' willingness to pursue additional learning of the subject matter taught during the learning unit. Attitude is the disposition which students develop toward the subjects. Both variables are measured by responses to questionnaire items.

Discussion of relationships in the model (see Figure 1)

Quality of instruction is the prime variable of the model. Although the model is not limited to specific quality of instruction conditions, the studies, which will explore the relationships depicted by the model, are concerned with three different qualities of instruction: (a) conventional, which typifies a minimal quality and is the most common instruction provided in schools, (b) tutoring, a less common experience, exemplifies a maximal quality, and (c) mastery learning, a quality less than the maximal of tutoring, but considerably higher than the minimal level of conventional instruction.

When students are given instruction of a minimal quality, the levels of achievement they will reach are predictable on the basis of aptitude and prior achievement because the instruction has no systematic means for correcting errors in learning or for assuring that most students

acquire the cognitive entry behaviors they need to benefit from the instruction. There is evidence that teachers in conventional settings direct cues toward students in the upper achievement range of the class and provide these students with more positive reinforcements and opportunities to participate (Brophy & Good, 1974). The result is that students within the same class may receive different qualities of instruction on the basis of their prior achievement.

A maximal quality of instruction should be adaptive to individual needs. Tutoring, for example, allows a constant readjusting of cues and reinforcement to the needs of the individual. A skillful tutor provides the right amount and kind of practice to insure that the student maintains a high level of participation in learning. In addition to the informal feedback given during the initial instruction as the tutor responds to the student's work, the tutor also provides systematic opportunities for the student to display the level of learning attained and to receive correctives. The feedback-corrective process, which is essential to a maximal quality of instruction, enables the student to acquire the cognitive entry behaviors needed to succeed in learning, despite prior characteristics.

To return to the model and the problem of students with varying prior characteristics, the same individual who is predicted to meet with little success under a minimal quality of instruction is predicted to achieve a high level of learning if given maximal instruction. In a maximal condition, all qualities of instruction are adapted to the needs of the individual during the initial presentation of the task, and learning is systematically assessed and corrected as needed. These procedures enable the student to enter each successive learning task with an optimal

level of prerequisite cognitive behaviors and to complete each unit with a high level of achievement.

The arrows connecting quality of instruction, time-on-task, and achievement indicate that both time-on-task and achievement are interactive and both are dependent on the quality of instruction. The mean percentage of time-on-task in a minimal quality of instruction conditions is expected to be low, with large disparities between the on-task behaviors of high and low achieving students. Since this quality of instruction does not incorporate a procedure which enables students to acquire the cognitive entry behaviors they need to succeed with the tasks, students who do not approach the task having previously acquired the cognitive prerequisites will find themselves increasingly unable to comprehend the instruction and to succeed in learning. The tendency of teachers to direct instruction toward and encourage participation from the high-achieving segments of the class further limits both the desire and ability of the remaining students to spend high levels of time in active learning.

Maximal qualities of instruction take care to provide that students possess the essential cognitive entry behaviors, which, in turn, enable students to benefit from instruction and participate actively in learning. Corrective procedures make it possible for most to learn as well as the small percent who attain the highest level of learning under minimal conditions. Tutorials, with their concentration on the needs of individuals and reliance on active participation, should affect the student's ability and desire to actively engage in learning. As a result, students under maximal learning conditions should behave as the high-achieving students of conventional instruction and exhibit high levels of time-on-task.

The model also depicts an interactive relationship between achievement, perception of achievement, and attitude and interest. The tendency

to develop positive affect toward what one does well and what is prized by the individual and the society is well documented. Academic success, prized by the general society, is accessible to only a few students under minimal instruction, leaving most students to perceive of themselves as less capable of learning and of meeting a criterion for success. Perceptions of inadequacy as a learner lead to apathetic or negative attitudes and interest toward learning, resulting in lower levels of achievement and perception of achievement. However, when the quality of instruction is maximal, almost all students should attain the highest levels of achievement and perceive of themselves as successful, academically capable individuals. This should, in turn, result in more positive attitudes and interest toward learning. It is expected that the interactive relationships which result in low levels of achievement, perception of achievement, attitude and interest under a minimal quality of instruction will result in high levels of achievement and affect under a maximal quality of instruction.

The relationships between quality of instruction and the cognitive and affective outcomes students attain are expected to change over a series of sequential learning tasks. As students in minimal quality conditions enter successive tasks, their achievement should either remain at a low level or decrease even further, and this should be accompanied by decreasing levels of time-on-task and affective entry characteristics. Maximal quality conditions should result in high levels of achievement. Students learning under this condition should develop increasingly high levels of on-task behaviors and affective entry characteristics as they progress through the learning tasks.

Following the model, students in mastery learning would be expected to exhibit levels of achievement, perception of achievement, time-

on-task and affect which are similar to students in conventional instruction for the first learning task. However, because instruction in the mastery groups is periodically individualized through the use of feedback and correctives, it would be expected that these students would attain increasingly higher levels of achievement, positive perception of achievement, time-on-task, and positive affect on successive learning tasks.

Variables

In this section, the variables introduced in the model and the methods which will be used to measure them are discussed in greater detail. As the model indicates, the studies are concerned with both stable and alterable variables.

Aptitude

For the purposes of the studies, aptitude is defined as an individual's general reasoning ability and ability to deal with abstract concepts. It includes the ability to interpret and use verbal and quantitative symbols and identify relationships among them. Aptitude is viewed as a stable characteristic of the learner.

The instrument used in measuring aptitude is the Cognitive Abilities Test (CAT), Multilevel, Form 3 (Thorndike & Hagen, 1978), which is administered by the cooperating school's personnel as part of their regular testing program. The CAT is composed of items which measure each of the abilities included in the definition of aptitude used for these studies. The CAT provides three separate batteries: verbal, quantitative, and nonverbal. Each is heavily loaded with a general reasoning factor, and the verbal and quantitative batteries are predictive of academic achievement as measured by the Iowa Test of Basic Skills.

When the academic content taught during a study is mathematics (probability), scores on the quantitative battery are used as the measure of aptitude. The quantitative battery is composed of tests of quantitative relations, number series, and equation building. When the academic content is social studies (cartography), the verbal battery scores are used as the measure of aptitude. The verbal battery is composed of tests of vocabulary, sentence completion, verbal classification, and verbal analogies.

Prior achievement

Prior achievement refers to the students' academic performance in the general subject areas which incorporate the specific topics taught during the studies. Teachers' grades for mathematics or social studies, awarded during the marking period which immediately precedes the studies, are used as the measure of prior achievement.

Quality of instruction

Quality of instruction is the major experimental variable of the studies. It is defined as the extent to which cues, reinforcement, participation, and feedback-correctives are accessible and appropriate to individual students (Bloom, 1976) and the extent to which students are held to an absolute criterion level on formative tests. Three qualitatively different instructional conditions are used in the studies: (a) conventional, (b) mastery learning, and (c) tutoring. Each is described in the following paragraphs.

1. Conventional quality of instruction classes are the control groups for the studies. Instruction is group-based; however, teachers' cues and positive reinforcements tend to be directed toward the students who are most able to benefit from the instruction, the high-achieving

students who comprise the upper third or fourth percent of the class. These students are also provided with greater opportunities to participate in learning than their lower achieving classmates. In conventional instruction, students are tested at the completion of tasks or units to provide a basis for assigning grades, but students proceed to new learning regardless of their test performance. Teaching practices which direct greater attention to the learning of some students than to others and allow students to enter new learning without the necessary cognitive entry behaviors are considered to provide a minimal quality of instruction.

2. Mastery learning classes are an enhanced version of conventional instruction. Although the primary instructional mode is group-based, feedback from diagnostic formative tests provides information about progress in learning to individual students and the teacher. Students who do not initially meet an 80 percent criterion set for mastery are given additional opportunities to participate in learning and are not introduced to new learning until most acquire the cognitive entry behaviors needed to succeed. Corrective strategies provide students with alternative cues and reinforcements, allowing for a periodic individualization of instruction.

3. Tutoring approximates a maximal quality of instruction because of its adaptability to the learning needs of individuals. A skillful tutor continually assesses the effectiveness of cues by observing the responses of the student, readjusting and adding cues when the need is indicated, and gauges the amount and kind of practice required to assure maximal level of participation by the student. Reinforcement is also based on individual need, and the close working relationships which evolve in successful tutorials allow the tutor to identify and supply

the forms of reinforcements most effective for the individual. Although the feedback-corrective process occurs informally throughout tutorials as tutors make spontaneous assessments of student learning and adjustments in instruction, good tutors also arrange for more formal evaluations of student learning through formative testing and set standards which the student is required to meet before proceeding to new learning. In the tutorials of the studies, students were held to a criterion of 90 percent accuracy on formative tests.

Quality of instruction is measured by the extent to which each component, included in the definition of the term, is present and by the students' perceptions of the quality of the instruction they receive, as indicated by their responses on questionnaires administered weekly. In addition, the tutorials were observed, and the extent to which each tutor maintained a maximal quality of instruction was recorded.

Achievement

Achievement is the level of learning exhibited by students on formative and summative tests. For students who are required to maintain an absolute criterion level on formative tests, achievement on formative tests is the number of correct responses on the first form of the test plus the number of correct items on alternative forms administered to students who do not initially meet the criterion set for their group. Achievement was measured at the completion of each learning task by formative tests and at the conclusion of each unit by a summative test.

Formative tests were based on the content and objectives of the learning tasks introduced during each week of the studies. The tests serve as diagnostic, progress measures for students in mastery learning and tutoring groups, providing teachers and students with information about

the extent of the learning which has occurred and indicating where correctives are needed by individuals. The tests served as weekly quizzes for the conventional groups, and students received information about their scores only, in keeping with conventional practice. Three formative tests were administered during each study.

The summative tests sampled the students' learning of the series of tasks taught during a learning unit and the extent of students' attainment of the unit objectives. The summative tests provided a means of assessing the final cognitive learning of students under each of the quality of instruction conditions.

Time-on-task

Time-on-task is the percent of time the student is observed to be engaged in the learning task and the percent of overt and covert time the student reports being engaged in learning. Time-on-task was measured in two ways: (a) observer ratings, and (b) student self-reports.

Observations were made by persons trained to use a scale developed by Good and Beckerman (1978) for coding student involvement in learning. The categories used in coding students' task behaviors were: definitely involved; definitely not involved; misbehaving. If the observer found no behavioral evidence for determining the extent of the student's involvement in learning, can't tell was coded. The definitely involved category was marked when there was behavioral evidence that the student was appropriately engaged in the task and definitely not involved, when the behaviors were inappropriate but not disruptive of others. Misbehaving was coded only when the student's behavior distracted others from the task. Student self-reports of both overt and

covert time-on-task were obtained from pertinent items on questionnaires administered once each week.

Perception of achievement

Perception of achievement is the subjective judgments made by students about the adequacy of the level of learning they attain. It refers to judgments about their achievement with the subjects taught during the brief, three week period of the studies. The judgments are probably based on a variety of sources, including reactions to grades they receive during the studies, interpretations of comments by teachers, parents, and peers, and comparisons which students draw between their own level of learning and that of others. Students' perception of achievement were obtained from their responses to items on questionnaires administered once each week. Items on the questionnaire were adapted from the Brookover Self-Concept of Ability measure and from scales developed for the National Longitudinal Study of Mathematics Achievement. The items require students to rank their achievement in comparison with classmates, to project how their achievement is ranked by others, and to indicate how they feel about overtly participating in class. Students who perceive their achievement as adequate are expected to respond more favorably to opportunities for publicly displaying what they have learned than are students who view their achievement as inadequate.

Affect toward learning

Affect toward learning refers to the attitude and interest students develop toward the subjects taught during the studies. Interest is the extent of the student's willingness to pursue additional learning of the subject taught during a learning unit. Attitude is the disposition which students develop toward the subjects. The definitions for interest and

attitude are adapted from Getzels' (1969). In these studies, an individual should report similar levels of attitude and interest toward the subject taught during a study because the subjects had not been previously studied and the content was not value laden.

Information about student interest and attitude toward the learning units was obtained from pertinent items on questionnaires. The items were adapted from affective scales developed for the National Longitudinal Study of Mathematics Achievement studies and from scales developed by Dolan (1974). Items dealing with interest ask if the student enjoys the learning tasks, finds that the subject has become a favorite, and wants to learn more about it. Attitude items ask if the student considers the subject useful and important to learn. Attitude and interest were measured once each week.

Hypotheses

The model posits quality of instruction as mediating between entry characteristics and the affective and cognitive outcomes students attain. Four hypotheses are derived from the model. In the following section, each is discussed in terms of operationalization and measurement.

Differential effects of quality of instruction on achievement

The literature provides evidence that higher levels of achievement with less variation are found when the quality of instruction students receive is improved either by providing feedback and correctives or by enhancing the other components of quality of instruction during the initial group instruction (Bloom, 1976; Block & Burns, 1977; Nordin, 1979). It would follow that the highest levels of achievement and the smallest variation in achievement should occur in a learning environment which enhances all components of quality of instruction for the individual

student during initial instruction and provides systematic feedback and correctives. It has been argued previously in this paper that tutoring is capable of providing this kind of maximal quality of instruction.

Although previous studies have investigated the effects of quality of instruction under mastery and conventional conditions, there are at present no other studies which investigate the effects of a maximal quality of instruction on student achievement. The following hypothesis is formulated to test the relation between achievement and different qualities of instruction, ranging minimal to maximal.

Hypothesis 1: Level and variation in student achievement is a function of the quality of instruction given the students.

The model underlying the studies proposes a causal linkage between the quality of the instruction students receive and the level of achievement they attain (see Figure 1). Achievement refers to student performance on formative and summative tests based on the content and objectives of a learning unit. Quality of instruction is the extent to which cues, reinforcement, participation, and feedback and correctives are present and appropriate to the needs of individuals (Bloom, 1976) and the extent to which students are held to a high criterion level for achievement on formative tests. Achievement and quality of instruction are described in more detail in the Variables section.

It was expected that the highest levels of achievement and the smallest variation would be found when students receive a maximal quality of instruction, provided by tutoring, and the lowest levels of achievement and largest variation would be found when students receive a minimal quality of instruction, provided by conventional group instruction. Achievement under mastery learning, a quality of instruction between the

two extremes of minimal and maximal, was expected to be significantly higher than the level of achievement for students receiving conventional instruction, but lower than for students receiving tutoring. Tutoring and mastery learning were expected to effect higher levels of achievement with less variation than conventional instruction because they both incorporate procedures for enabling students to enter new learning tasks with high cognitive and affective entry behaviors. Tutoring was expected to result in the the highest levels of achievement because it adapts other components of quality of instruction (i.e., cues, reinforcement, and participation) to individual needs as the task is initially presented.

The hypothesized causal relationship between achievement and quality of instruction was tested by examining the means and standard deviations on formative and summative tests for students learning under each quality of instruction condition. It was expected that the means and standard deviations for formative test achievement would reveal that students in tutoring and mastery classes attained increasingly higher levels of achievement on successive tests, with progressively smaller variation than found for conventional groups. It was expected that the means for the conventional instruction groups on formative tests would either remain at a relatively constant, low level or would decrease on each successive test and that the standard deviation would remain large for achievement on each test.

Relations between antecedent conditions and subsequent achievement

Previous research has shown that under conventional instruction aptitude and prior achievement are predictive of subsequent achievement. Research has also shown that under the more favorable quality of instruction provided by mastery learning the effects of aptitude and

prior achievement on subsequent achievement are diminished (e.g., Nordin, 1979; Froemel, 1980).

The model posits quality of instruction as intervening between the effects of students' prior characteristics and their subsequent achievement (see Figure 1). When the quality of the instruction is adaptive to the needs of individual learners and students are enabled to acquire the cognitive prerequisites for succeeding with the new learning, there should be little relation between aptitude and prior achievement and the achievement the students subsequently attain. However, if the quality of the instruction does not systematically enable students to gain cognitive prerequisites, aptitude and prior achievement would be expected to exert a strong influence on the subsequent achievement the students are able to attain. The second hypothesis is formulated to test the relation between aptitude, prior achievement, and subsequent achievement under different quality of instruction conditions.

Hypothesis 2: The relation between student achievement and prior measures of achievement and aptitude is determined by the quality of the instruction given the student.

This hypothesis elaborates on the first by proposing that the effects of quality of instruction are pervasive and influence not only achievement, but also the extent of association between students' prior characteristics and their subsequent achievement. Achievement and quality of instruction were defined in the discussion of the first hypothesis. Prior achievement refers to the students' level of learning in the general subject area which incorporates the content to be taught during the studies. It is measured by teacher's grades. Aptitude refers to the

individual's general reasoning ability and ability to deal with abstract concepts, as measured by the Cognitive Abilities Test. A more detailed description of prior achievement and aptitude and the measures used for each is included in the Variables section.

In the hypothesis statement, "relation" refers to the strength of the association between students' characteristics, aptitude and prior achievement, and their subsequent achievement. It was expected that the relation would be weak when students received a maximal quality of instruction, but strong when students received a minimal quality of instruction.

Correlations between prior achievement and achievement on formative and summative tests and between aptitude and achievement on formative and summative tests were examined for students in the different quality of instruction conditions provided by tutoring, mastery learning, and conventional instruction. The lowest correlations were expected for the tutoring group, where instruction was focused on the needs of individuals and feedback/correctives were provided. Correlations for the mastery group were also expected to be small because this condition, like tutoring, enables students to enter new learning with prerequisite cognitive behaviors, regardless of prior characteristics. Strong relations between prior characteristics and subsequent achievement were expected for the conventional instruction group. It was expected that the few students who entered the learning with optimal prior characteristics would succeed in learning, but since the majority of students did not possess optimal characteristics, they would have limited success in learning.

It was expected that the correlations between aptitude and prior achievement and formative test achievement would decrease in both

the tutoring groups and the mastery learning groups as students progressed through the sequence of learning tasks. However, the correlations were expected to remain large and relatively stable for students receiving conventional instruction.

Relations between involvement in learning and quality of instruction

Studies comparing time-on-task under mastery learning and conventional instruction generally report that students in the more favorable quality of instruction provided by mastery learning exhibit significantly higher levels of time-on-task with less variation than is found for students in conventional instruction (Bloom, 1976; Block & Burns, 1977; Anderson, 1973). Nordin (1979) found that enhancing components of quality of instruction during group instruction also results in significantly higher levels of involvement in learning than occurs during conventional instruction.

There are no studies which investigate the extent of students' engagement in learning when they are given a maximal quality of instruction. However, it would be expected that a maximal quality of instruction would result in optimal student engagement in learning. The following hypothesis is formulated to test the relation between student involvement in learning and quality of instruction.

Hypothesis 3: Level and variation in the percentage of time students are actively engaged in learning is a function of the quality of instruction students are given.

The model represents time-on-task as a direct outcome of quality of instruction and as a process interacting with achievement (see Figure 1).

In the hypothesis statement, the phrase "percentage of time students are actively engaged in learning" refers to both overt and covert participation in learning. This is operationalized as observed time-on-task and as students' perceptions of their overt and covert participation in learning. The instruments used in measuring students' perceptions of their participation and observed time-on-task are discussed in the Variables and Procedure sections.

It was expected that the highest levels of time-on-task and the smallest variations would be found when students receive a maximal quality of instruction. This was expected because the teacher to pupil ratio of tutoring allows for greater interaction between teacher and student and because each of the qualities of instruction are adapted so the student gains the prerequisite cognitive behaviors for understanding and succeeding with the tasks.

It was also expected that students in the group-based instructional conditions would be fairly similar in time-on-task during the first learning task. However, the mastery learning and conventional instruction groups were expected to become increasingly divergent as the mastery students received feedback/correctives and entered subsequent tasks with the cognitive prerequisites for learning from the instruction. Mastery learning students were expected to show increases in time-on-task as they progressed through the unit, and variations in time-on-task were expected to decrease because the condition enables almost all students to attain high levels of academic success. However, students in the conventional instruction groups were expected to become less actively involved in learning as they entered subsequent tasks with fewer of the necessary prerequisite learnings. The learning tasks of the units were sequential, and students who did not achieve a high level of learning on one task

would have difficulty with the next. The frustrations of attempting to learn without having acquired the necessary cognitive entry behaviors are likely to lead a large proportion of students to become discouraged and make fewer attempts to learn. This should be reflected in lower levels of time-on-task and increased variation within the group, as a small percentage of students continue to learn despite the minimal quality of the instruction, and the majority fail because of it.

The hypothesis was examined by analyzing the means and standard deviations of total time-on-task under each condition. Means and standard deviations were examined for each learning task of the studies to determine whether an association exists between quality of instruction and changes in time-on-task.

Relations between affect, achievement, and perception of achievement

Although the literature provides mixed reports on the relation between affect and achievement and offers conflicting hypotheses about the direction of causality between the two, there is a growing body of evidence that affect develops as a response to the students' accumulated experiences of attaining high levels or low levels of achievement. The literature also indicates that students' perceptions of their achievement most likely evolve from the achievement they attain, as measured by teachers' grades.

The results of mastery learning studies as summarized by Bloom (1976) and Block and Burns (1977) and of Nordin's (1979) study of the effects of enhancing group instruction strongly suggest that higher levels of attitude and interest toward learning are found when students are provided with a quality of instruction which enables them to attain high

levels of achievement. This relation has not been examined under a maximal quality of instruction, however.

It has been argued previously in this paper that students' attitude and interest toward learning are influenced by their perceptions of achievement, as well as their achievement. The following hypothesis is posited as a test of the relation between affect, achievement and perception of achievement.

Hypothesis 4: Attitude and interest toward learning develops as a function of the achievement students attain and of their perception of the adequacy of their achievement.

The model (see Figure 1) depicts the relationships between achievement, perception of achievement, and attitude and interest as complex and interactive. It is hypothesized that the extent to which students succeed in learning and perceive themselves as succeeding strongly influences the attitude and interest they develop toward learning.

Attitude refers to the students' disposition toward the learning. Interest refers to the extent of the students' willingness to pursue additional learning of the content taught during the studies. Perception of achievement is defined as the students' self-reports of general school and subject-specific achievement. It refers to the way students view their own history of achievement and to the way they view their achievement on the tasks taught during the studies.

Attitude, interest, and perception of achievement were measured on the day preceding the administration of a formative test; they are measured at three points during each study (see Table 1 in the Procedures section). The variables and methods used in measuring them are discussed in the Variables section.

Following the relationships posited in the model, a maximal quality of instruction should result in students attaining high levels of achievement, and this should result in high levels of positive perceptions of achievement. The combination of high achievement and positive perception of achievement is expected to effect high levels of positive attitude and interest toward learning. The opposite effects are expected when the quality of instruction is minimal. A minimal quality of instruction should result in low levels of achievement and perception of achievement, and this, in turn, is expected to result in low levels of attitude and interest in learning.

It was expected that the attitude and interest reported by students in tutoring would be higher throughout the studies than the attitude and interest of students in mastery learning and conventional instruction. Students in tutoring were expected to attain the highest levels of achievement and, therefore, perception of achievement. It was also expected that because mastery learning provides a more favorable quality of instruction than conventional instruction the levels of positive attitude and interest in mastery learning groups would be higher than those found for conventional instruction groups.

The hypothesis was investigated by examining the multiple correlations between final measures of attitude and interest and achievement and perception of achievement under each quality of instruction condition. The predictiveness of achievement and perception of achievement was explored by examining the regression of attitude and interest on achievement and perception of achievement under each quality of instruction condition at the beginning and end of each learning unit.

Design

Each of the three studies conformed to Campbell and Stanley's (1963) criteria for an experimental, posttest-only, control group design. The academic content students learned during each study had not been previously encountered by them; therefore, pretest measures would have been inappropriate. Students were randomly assigned to control and experimental conditions in an attempt to assure the initial equivalence of students learning under each of the conditions. Means and standard deviations for the students' aptitude, as measured by the Cognitive Abilities Test, and prior achievement, as measured by teachers' grades, were examined to determine if random assignment resulted in comparability of the students in each condition.

Three separate studies were conducted, using three different samples of students and two different content areas. In the first two studies, fourth and fifth grade students were taught probability, and in the third study, eighth grade students were taught cartography. The quality of instruction conditions used in the studies were: (a) tutoring, (b) mastery learning, and (c) conventional, which serves as the control. These conditions are described in the Variables section. Briefly, tutoring provides students with a maximal quality of instruction and conventional, with a minimal quality of instruction. Mastery learning provides a quality between the two extremes.

All students assigned to tutoring groups were taught by undergraduate education majors enrolled in a private college. Although the original intent was to provide one-on-one tutoring in each of the studies, it was not possible to obtain a sufficient number of tutors for students in the fourth and fifth grade studies. In the fourth and fifth grade studies,

each tutor was responsible for three students each. However, one-on-one tutoring was provided in the eighth grade study.

Subjects

All students participating in the studies attended a parochial school located in a middle-income neighborhood on the Southwest side of Chicago. The total population of the school's fourth, fifth, and eighth grades were involved in the studies.

The students' mean aptitude scores on the CAT, which the school administers annually at the end of fourth and sixth grade, fall within the range of mean scores reported for the norming sample in the CAT technical manual. The mean score on the quantitative battery for the norming sample is 104.4 with a standard deviation of 18.4 (Thorndike & Hagen, 1974). The mean score for fourth grade students in the studies is 112.90 and for fifth grade students is 111.16. The mean score on the verbal battery for the norming sample of sixth grade students is 125.0 with a standard deviation of 20.0. The mean score for eighth grade students, who were tested during the sixth grade, is 107.86. These scores indicate that the groups of students participating in the studies are similar in aptitude to the larger student population sampled during the norming of the CAT.

The school has a history of cooperation with college methods courses, and students assigned to tutoring conditions did not appear to view their participation in tutorials as unusual or special. An attempt was made to avoid disruptions in the normal procedures of the school as much as possible, considering the experimental nature of the studies.

Academic content

Probability and cartography were selected as the academic content to be taught during the studies because both depend on sequential learning and neither had been previously studied by the students. In addition, the content of probability or cartography could be presented in an intellectually honest way to students in grades four and five or eight and would make positive contributions to the students' educational development.

It was important that students entered the studies with no prior experiences of either success or failure in learning the specific content taught during the studies. The students, doubtlessly, recognized the connection between the specific subjects of the studies and more general subject areas. Probability was taught during the period normally reserved for mathematics and cartography, during the social studies period. Also, mastery and conventional groups were taught by teachers who are normally responsible for mathematics and social studies instruction. However, by introducing the content as new and unrelated to the students' previous work and by referring to the learning units as probability and cartography, terms unfamiliar to the students, an attempt was made to diminish the effects of general subject affect.

Materials for teaching probability were adapted from the following sources: Probability for Intermediate Grades (School Mathematics Study Group, 1966); A Study of the Development of a Unit in Probability and Statistics for the Elementary School (Shepler, 1969); What Are My Chances, Book A (Shulte & Choate, 1977). The following sources were used in preparing the cartography unit: The Rand McNally Handbook of Map and Globe Usage, 4th ed. (Harris, 1967); Steps in Map Reading (Anderzhon, 1970);

Mapping (Greenhood, 1964). Teachers and tutors were given copies of the unit materials before each study began. The materials included unit objectives and content outlines, suggestions for teaching strategies, background information for the teachers, copies of the instructional materials and answer sheets. In addition, teachers and tutors were given the same sets of pupil practice sheets, manipulatives, and visuals needed for each unit.

Procedure

A schedule of instruction, observations, and testing is provided on Table 1 (see following page). Each study was conducted during a three-week period and incorporated three sequential learning tasks. As Table 1 indicates, during the first two weeks of each study, students received a total of four periods of instruction (each lasting 40 minutes) before formative tests were administered. Students in the tutoring and mastery groups, who did not initially meet the criterion set for their respective groups, were given additional help in learning the material sampled by the test items they missed. The additional help was provided by the tutor or by teachers and peers, depending on the condition. An alternate form of the test was administered, and if students still did not meet the criterion, the feedback and corrective process was repeated.

In the third week (see Table 1), students received three periods of instruction (40 minutes each) on the final task before the formative test was administered. Again, students in mastery and tutoring groups received correctives as needed to meet the criterion set for their group. Summative achievement tests were administered to all groups on the following day, the final day of the study.

TABLE 1

SCHEDULE OF INSTRUCTION, OBSERVATIONS, AND TESTING FOR CARTOGRAPHY AND PROBABILITY STUDIES

	Week 1	Week 2	Week 3
Instruction	4 periods	4 periods	3 periods
Observation of Tutors	2 periods	2 periods	2 periods
TOT Observations of All Groups	3 periods	3 periods	2 periods
*Student Questionnaires [a]	4th period	4th period	3rd period
Formative Tests for All Groups	5th period	5th period	4th period
Feedback/Correctives for Tutoring and Mastery Groups	5th period	5th period	4th period
Summative Tests	----------	----------	5th period

[a]Student Questionnaires are composed of items from instruments measuring students' : (a) perception of quality of instruction, (b) perception of achievement, (c) perception of overt and covert time-on-task, and (d) attitude and interest.

As Table 1 indicates, student questionnaires were administered once each week. Items for the questionnaires were taken from instruments for measuring the students' perceptions of achievement, overt and covert time on task, and attitude and interest. Each of these is discussed in the Variables section. Items from an instrument for measuring the students' perceptions of quality of instruction were also included on the questionnaire, as part of the effort to monitor the quality of instruction available under the three different conditions. Observations of time-on-task for students in each condition were made three times each week during the first two weeks and twice during the final week. Methods for observing time-on-task are described in the Variables section, also.

Observations of the quality of instruction provided by tutors were made twice each week by the college instructor responsible for training the tutors. The following categories were coded when tutors were observed: (a) arrives on time for the tutorial, (b) has organized materials for instruction, (c) provides a clear explanation of each task, (d) provides additional and altered cues when needed, (e) reinforces correct responses and appropriate behaviors, (f) uses a variety of verbal and nonverbal behaviors to encourage participation.

Instruments for measuring the following variables are provided as appendices: (a) perception of quality of instruction, (b) perception of achievement, (c) perception of overt and covert time-on-task, (d) attitude and interest. Student questionnaires and the coding sheet for observing tutors are also included as appendices.

CHAPTER IV

RESULTS OF THE STUDIES

The studies were undertaken to examine the effects of the quality of instruction students receive on the cognitive and affective outcomes they attain. Three different quality of instruction conditions were used: tutoring, which approximates a maximal condition, conventional, which approximates a minimal condition, and mastery learning, a condition which is viewed as falling between the two extremes.

Three studies were conducted, using three different grade levels and two different content areas. Students in grades four and five were taught probability under tutoring, mastery, and conventional conditions. Students in grade eight were taught cartography under the different quality of instruction conditions. Eighth grade students in the maximal condition received one-on-one tutoring, while students in the fourth and fifth grade maximal conditions were tutored by teachers who were responsible for instructing three students (see Chapter III for details).

In discussing the results of the studies, the first question examined is whether students learning under different quality of instruction conditions attain different levels of achievement. The second question concerns the relationship between such student characteristics as aptitude and prior achievement and the student's subsequent achievement. It is also concerned with the extent to which quality of instruction can alter these relationships. The third question concerns the extent of active

engagement in learning which occurs under each quality of instruction condition. The final portion of the chapter treats the affect (attitude and interest) students develop toward learning under the three conditions and whether it reflects their achievement and their perception of themselves as learners. Before discussing the results of the studies, the initial comparability of students in each quality of instruction condition for the studies will be examined.

Initial comparability of students

All three studies were conducted in a parochial school located in a middle-income neighborhood on the Southwest side of Chicago. In order to secure comparability, students in each of the studies were randomly assigned to one of the quality of instruction conditions. The extent to which random assignment resulted in comparable groups was determined by examining the means and standard deviations for aptitude and prior achievement between the groups in each study. In the fourth and fifth grade studies, aptitude was operationalized as the students' scores on the quantitative battery of the Cognitive Achievement Test and prior achievement as teacher grades for mathematics. In the eighth grade study, aptitude was operationalized as students' scores on the verbal battery of the Cognitive Achievement Test and prior achievement as teacher grades for social studies.

Table 2 summarizes the means and standard deviations for aptitude and for prior achievement. In all but one instance, random assignment of students to conditions resulted in comparable means and standard deviations in aptitude for the three groups within each grade level study. The one exception involves the comparison of the aptitude means for the fifth grade tutoring and conventional groups. The mean level of aptitude

TABLE 2

COMPARISON OF APTITUDE AND PRIOR ACHIEVEMENT

Groups	n		Aptitude			Prior Achievement
Fourth Grade						
Tutoring	20	$\bar{x}$	110.45	20	x	2.45
		s	12.69		s	.69
Mastery	26	$\bar{x}$	114.00	26	x	2.50
		s	10.08		s	.76
Conventional	24	$\bar{x}$	113.75	24	x	2.58
		s	12.61		s	.78
Total Fourth	70	$\bar{x}$	112.90	70	x	2.51
		s	11.69		s	.74
Fifth Grade						
Tutoring	20	$\bar{x}$	116.45*	20	x	2.75
		s	11.97		s	.72
Mastery	22	$\bar{x}$	109.45	26	x	2.58
		s	11.77		s	.50
Conventional	28	$\bar{x}$	108.71	28	x	2.68
		s	13.49		s	.55
Total Fifth	70	$\bar{x}$	111.16	74	x	2.66
		s	12.82		s	.58
Eighth Grade						
Tutoring	21	$\bar{x}$	107.24	21	x	2.67
		s	9.06		s	.73
Mastery	28	$\bar{x}$	109.18	28	x	2.75
		s	11.63		s	.70
Conventional	29	$\bar{x}$	107.03	33	x	2.58
		s	12.15		s	.71
Total Eighth	78	$\bar{x}$	107.86	82	x	2.66
		s	11.11		s	.71

* $p < .05$

for fifth grade tutoring is significantly higher at the .05 level than the mean for the conventional group. However, as Table 2 indicates, the mean levels of prior achievement for the fifth grade tutoring and conventional groups are similar. No significant differences at or above the .05 level in means or variation for prior achievement were found between students learning under the different quality of instruction conditions within each grade level.

Table 2 provides data for only those students who remained in the studies. In each study, there were students who were absent on testing days. Data for these students were not retained in the studies. The greatest losses in each study were due to absence on the day when the final formative test was administered or absence for the summative test. The smallest loss occurred under tutoring conditions. This is understandable because tutors could arrange to administer tests which had been missed, while such arrangements were more difficult in the group-based conditions. All losses which occurred in the fourth and fifth grade tutoring were due to absences on the day of the summative test. In the eighth grade tutoring, three students were lost because of extended absences, but three additional students were lost to the study because their tutors were consistently unprepared to instruct and frequently did not appear for the tutoring sessions. With the exception of five students in the eighth grade mastery group, all losses from mastery conditions were due to absences on testing days. The five eighth grade students were either unable to remain after school for corrective instruction when needed or chose not to participate in the study. Losses in mastery and conventional groups were proportionately equal. No particular pattern emerged which might be used to characterize the students who were absent during the studies.

Effects of Quality of Instruction on Achievement

In the earlier discussion of the model underlying these studies (see Chapter III), a causal relationship was posited between the quality of instruction students receive and the achievement they attain. Quality of instruction is the extent to which cues, reinforcement, participation, and feedback and correctives are present and appropriate to the needs of individuals (Bloom, 1976) and the extent to which students are held to a high criterion level for achievement on formative tests. Achievement refers to the level of learning exhibited by students on formative and summative tests during a unit of study.

Instruction is viewed as a qualitative continuum, ranging from minimal to maximal. In order for an instructional condition to be classified as maximal, it must adapt cues so they can be understood and used by the individual, provide reinforcements which maintain or increase the individual's desire for further learning, and arrange for the individual to receive the amount and kind of practice needed to succeed in learning. It must also incorporate a means of providing teacher and student with feedback about the level of learning which has been attained and of providing students with corrective instruction as weaknesses or errors in learning are identified so that the student is able to maintain a high level of achievement throughout a series of learning tasks.

Tutoring is probably the best example of a condition capable of providing a maximal quality of instruction. When tutoring meets the requirements for classification as a maximal quality of instruction (see preceding paragraph), it is expected that students learning under this condition will attain higher levels of achievement than students under less favorable conditions. It is also expected that the achievement

levels of the students will be more similar because they receive instruction adapted to their individual learning needs. When students in tutoring conditions are taught a series of sequential learning tasks, their initial level of learning should be high and, because the quality of instruction should enable them to enter each successive task with prerequisite cognitive entry behaviors, their levels of learning should remain high or increase over the series of learning tasks.

The quality of instruction normally provided in schools is viewed as approximating a minimal quality of instruction, as argued in Chapter I. Much of the instruction provided in schools provides clear cues, frequent reinforcements, and encouragement for participation primarily for the high achieving students. Feedback and corrective components are rarely available. Conventional instruction is not adaptive to individual learning needs and does not attempt to assure that the majority of students attain high levels of learning. There is ample evidence that only a few students reach high levels of learning under conventional conditions and that large variations in achievement exist among the students. Under conventional conditions, the achievement levels of students over a series of sequential tasks would be expected to progressively decrease because the condition has no provision for enabling almost all of the students to attain the entry behaviors they need to succeed with each new task.

Mastery learning is a quality of instruction which lies between the two extremes exemplified by tutoring and conventional instruction, as discussed in Chapters I and III. Although students in mastery and conventional conditions receive initial instruction which is essentially the same, mastery students receive periodic feedback and corrective instruction, assuring that they meet a predetermined criterion for learning and enter

new tasks with the necessary cognitive entry behaviors. Under mastery conditions, students would be expected to attain levels of achievement which are above the levels of conventional groups, but below the levels of tutoring groups. The students should also attain more similar levels of achievement than conventional groups.

The following hypothesis was formulated to test the effects of different quality of instruction conditions on student achievement.

Hypothesis 1: Level and variation in student achievement is a function of the quality of instruction given the students.

Achievement refers to the level of learning exhibited by students on formative and summative tests based on the content and objectives of a learning unit. Level is operationalized as mean achievement and variation, as standard deviations. Quality of instruction is the extent to which cues, reinforcement, participation, and feedback/correctives are present and appropriate to the needs of individuals (Bloom, 1976) and the extent to which students are held to a high criterion level for achievement on formative tests. Student achievement was examined under three quality of instruction conditions: tutoring, mastery learning, and conventional instruction.

Three separate studies were undertaken. In the first two studies, fourth and fifth grade students were taught probability, and in the final study, eighth grade students were taught cartography. The three quality of instruction conditions were used in each study.

The highest levels of achievement and smallest variations were expected for students receiving tutoring, and the lowest levels and largest variations were expected for students under conventional instruction conditions. Levels and variations for students in mastery learning conditions

were expected to fall between the two extremes. The results for summative achievement are discussed first. This is followed by a discussion of the changes in achievement which occurred over the series of learning tasks taught during each study.

Effects of Quality of Instruction on Summative Achievement

In each of the three studies, the highest mean levels of summative achievement are found for students who received tutoring, the maximal quality of instruction condition. As Table 3 indicates, the summative achievement of tutoring groups is significantly different at the .001 level from the achievement of conventional groups at each grade level. The achievement levels attained by tutoring groups are an average of 32% higher than for conventional groups.

Levels of summative achievement are also higher for the mastery groups than for the conventional groups by about 17%, and as shown on Table 3, the differences in summative achievement for mastery and conventional groups are significant in each study. The summative achievement for fifth and eighth grade mastery groups is significantly different at the .001 level from conventional groups, and in the fourth grade, the achievement of the mastery group is significantly different at the .05 level from the conventional group's achievement.

The hypothesis states a causal linkage between the quality of instruction students receive and the level of achievement they attain. Earlier, Bloom (1976) estimated that at least one-fourth of the variance in student achievement could be accounted for by quality of instruction. When the data from the studies presented here are analyzed using multiple regression procedures (stepwise inclusion), quality of instruction

TABLE 3

COMPARISON OF MEANS AND STANDARD DEVIATIONS

FOR FORMATIVE AND SUMMATIVE ACHIEVEMENT

Group		FT 1A	FT 1B	FT 2A	FT 2B	FT 3A	FT 3B	Summative
Fourth Grade								
Tutoring (n = 20)	$\bar{x}$	77.75	94.75	68.50***	93.75	57.14***	89.64	78.21***
	s	17.73	5.25	20.40	6.04	20.34	13.80	13.75
Mastery (n = 26)	$\bar{x}$	78.46	88.46	53.85**	80.19	40.93	64.29	58.52*
	s	14.95	7.97	21.51	9.64	15.06	14.57	17.41
Conventional (n = 24)	$\bar{x}$	72.08		38.33		37.80		48.07
	s	15.53		20.14		13.73		17.05
Fifth Grade								
Tutoring (n = 20)	$\bar{x}$	94.00***	95.50	80.50***	92.75	54.29***	93.93	84.82***
	s	9.95*	4.56	16.30	5.50	13.19	9.35	11.87
Mastery (n = 26)	$\bar{x}$	80.00	90.19	62.12	83.65	45.88	75.00	72.80***
	s	13.78	10.72	19.40	6.86	16.68	12.00	14.47
Conventional (n = 28)	$\bar{x}$	80.00		51.96		36.22		52.55
	s	15.09		18.02		13.87		15.64
Eighth Grade								
Tutoring (n = 21)	$\bar{x}$	80.95***	95.48	75.87***	97.78	80.32***	98.10	81.14***
	s	12.91	4.45	16.53	3.85	12.38	3.09	10.37*
Mastery (n = 28)	$\bar{x}$	64.82*	81.61	72.14***	88.81	72.62***	91.43	67.14***
	s	18.48	10.37	17.78	8.52	19.06	8.09	17.87
Conventional (n = 33)	$\bar{x}$	54.39		43.23		42.22		49.21
	s	18.40		15.82		18.23		16.36

Comparisons were made between tutoring and conventional and between mastery and conventional in determining differences in means and standard deviations.

*p < .05
**p < .01
***p < .001

accounts for 36% of the variance in summative achievement for the fourth grade, 48% of the variance for the fifth grade, and 41% for the eighth grade. These results indicate that the achievement students attain is strongly affected by the quality of instruction they receive.

Within quality of instruction conditions, the least variation in summative achievement is found among students in tutoring groups. Variance within tutoring groups is an average of about 46% less than the variance found for conventional groups. The greatest difference in variation between tutoring and conventional groups occurs in the eighth grade study, where the variance is less than one-half the size of the variance for the conventional group.

Variation in achievement is not consistently smaller for mastery than for conventional groups. In the fifth grade study, variance found among mastery students is smaller than for the conventional instruction students by about 14%. However, in the fourth and eighth grades, variance in achievement is slightly larger for mastery than for conventional groups. Although the corrective strategies were effective in increasing the level of achievement for the eighth grade mastery students, it is possible that the instruction was not sufficiently adaptive to enable all of the students to retain and apply the learning acquired during the corrective sessions to the problems posed on the summative test. The larger variation which occurs for the fourth grade mastery group is probably due to insufficient corrective instruction following the third learning task. As Table 3 indicates, the corrective instruction the fourth grade mastery students received did not enable the majority of the students to reach an 80% mastery criterion on FT 3B, and many students left the third task with low levels of learning and inadequate preparation for the problems posed on the

summative test. However, with the exception of variation within the fourth and eighth grade mastery groups, achievement on the summative test provides the predicted pattern of higher levels and smaller variations for students who received instruction adapted to their learning needs.

The cumulative effects of providing students with a quality of instruction which approximates the maximal for meeting the learning needs of each individual is graphically illustrated on Figure 2. In the studies, more than 90% of the students in tutoring meet or exceed achievement levels reached by only the top 20% of the students in conventional conditions. Figure 2 also illustrates the differences in achievement distributions between students in mastery and conventional conditions. An average of nearly 70% of the students in mastery conditions met or exceeded the levels of achievement attained by only 20% of the highest scoring students in conventional conditions.

While the considerable differences in the distribution of achievement between tutoring and conventional groups can be attributed to the extreme differences in the quality of instruction available in the two learning conditions, the differences in the summative achievement of mastery and conventional groups are due to the addition of only one component to a group-based instructional condition--the feedback/corrective strategies. In contrast to the constant adaption of instruction which occurred in the tutoring groups, in mastery and conventional groups there was no emphasis on adjusting either teaching behaviors or instructional materials to the needs and interests of each student during the initial presentation of a learning task. The amount of attention to individual needs which is possible in tutoring is not possible in group-based

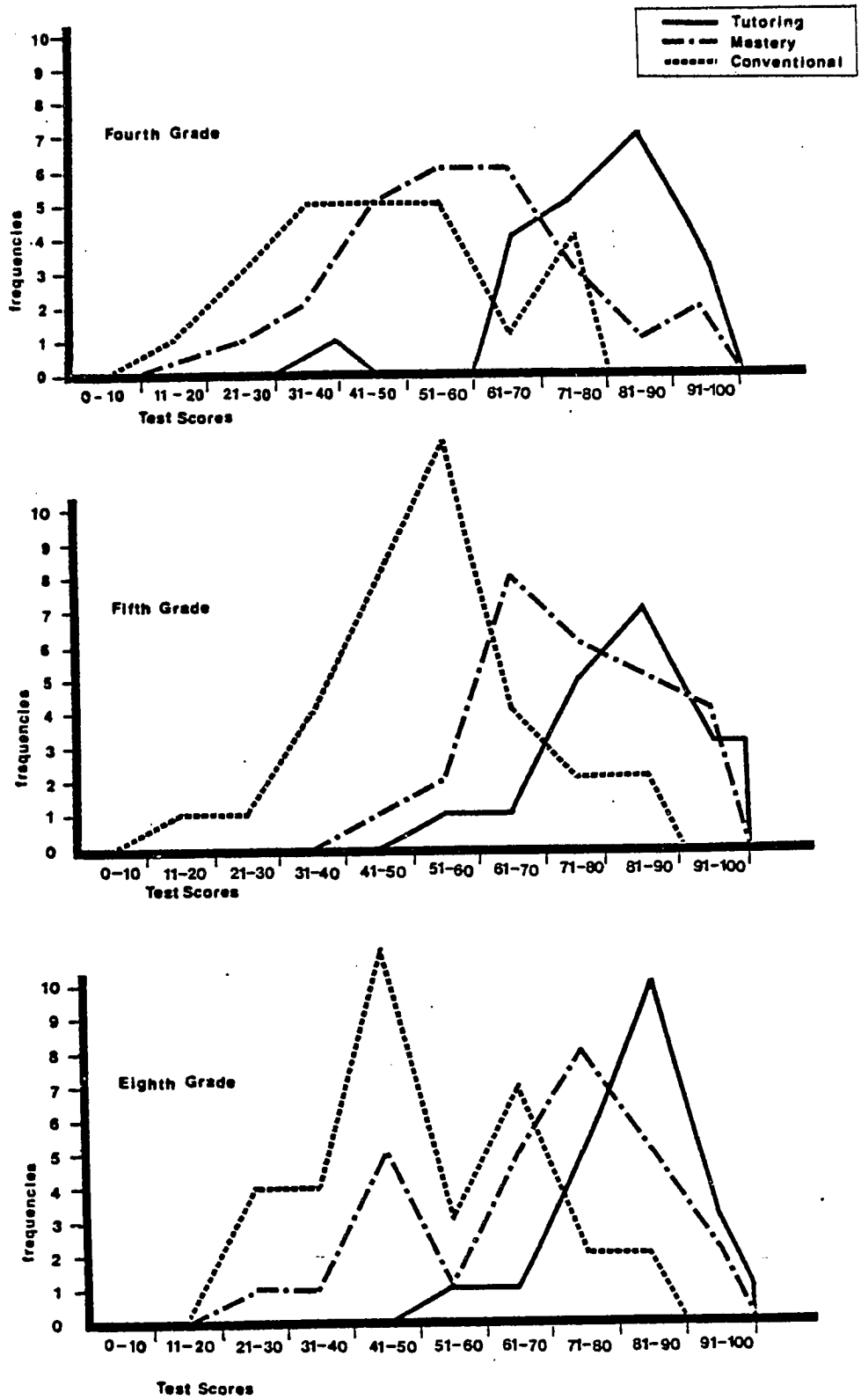

Fig. 2. Summative Achievement Distributions

conditions. Students in mastery and conventional instruction received the same explanations and worked with the same materials during the initial presentation of the tasks, regardless of the extent of their success in comprehending the instruction. In addition, the reinforcements provided in conventional and mastery groups were generally directed to the group, rather than to individuals.

However, in the mastery condition, group instruction was periodically supplemented with individualized instruction. At the completion of each learning task, students who did not meet the 80% criterion for learning, which was required for the mastery condition, received additional, corrective instruction on the specific elements of the task not learned well during the initial instruction. This corrective instruction was provided primarily by volunteers from among the undergraduate education majors working with the tutoring group. With the one exception noted earlier concerning the use of correctives with the fourth grade mastery group following the third task, the corrective instruction enabled students to attain high levels of learning over each of the tasks of the learning units and to approach new tasks with the cognitive prerequisites for comprehending the instruction. The availability of the feedback/corrective component to mastery students accounts for levels of summative achievement consistently higher than the conventional groups. The role of feedback/correctives in providing tutoring and mastery students with a higher quality of instruction becomes more apparent in examining the changes which occurred in achievement between students in different learning conditions over the series of tasks for each study.

Achievement on the first learning task

The mean levels of achievement for students receiving tutoring are an average of 15% higher than the means for conventional group students on the first formative test (FT 1A), despite a procedural problem which curtailed the amount of instructional time available to the fourth grade tutoring group during the first learning task. The greatest difference in mean achievement for tutoring and conventional groups occurs in the eighth grade study, where the mean for the tutoring group is about 27% higher than the mean for the conventional group.

In the fourth and fifth grades, tutors were responsible for the instruction of three students each, and it is likely that they had to devote some time to differentiating the learning needs of each student during the first task before they could begin providing an optimal learning environment for every individual. In the eighth grade study, tutors were responsible for a single student and so it would be expected that their focus on the learning of just the one individual would result in their being able to adjust instruction to individual needs more rapidly.

The quality of instruction provided to students in mastery and conventional groups was essentially the same during the first learning task, and theoretically, the mean levels of achievement for these groups should have been very similar. In the fifth grade study, the mean achievement for mastery and conventional groups were exactly the same (e.g., 80%). However, the levels of achievement for fourth and eighth grade mastery students were an average of 8% higher than the conventional groups. It is possible that mastery group students, who were informed that they would be receiving assistance in meeting a criterion of 80% correct on

formative tests, were slightly more motivated to attend to the initial instruction for the first learning task. This could account for the minor differences in level of achievement found on FT 1A.

Achievement after corrective instruction. In tutoring and mastery groups, the results of the first formative test were used to identify areas of weakness and errors in learning. Corrective instruction was then provided on an individual basis, and an alternate version (FT 1B) of the original test was administered to determine if students met the achievement criterion set for their groups. The mean levels of achievement after corrective instruction increased to an average of about 95% in the tutoring groups and about 87% in the mastery groups, assuring that students in these groups entered the second learning task with the cognitive entry behaviors they needed to benefit from the instruction. As Table 3 indicates, variation in achievement after corrective instruction is very small for both tutoring and mastery groups.

Achievement on the second learning task

On the second learning task, the differences in the achievement levels attained by tutoring and conventional groups increase further. The mean achievement for tutoring groups on the second formative test (FT 2A) is an average of 30% higher than for conventional groups. The disparity between the quality of instruction available to tutoring and conventional groups during the presentation of a task would account for the groups' different levels of achievement. However, the disparity in initial instruction is not in itself sufficient to explain why the average spread between the achievement levels of the groups should double on the second task from 15% to 30%.

Although the average distance between the levels of achievement for tutoring and conventional groups on the first learning task was only 15%, it increased to an average of 26% after the tutoring groups received corrective instruction on the first learning task (see Figure 3). The extent to which the tutoring and conventional groups have acquired the prerequisite learning for succeeding with the second task is reflected in the widening gap between the achievement of the groups on the second formative test.

Achievement for mastery groups was also higher on the second learning task than for conventional groups. The mean achievement for mastery groups is an average of 18% higher than for conventional groups on the second formative test (FT 2A). Corrective instruction following the first formative test resulted in the mastery groups attaining mean levels of achievement on the alternate test (FT 1B) which averaged about 18% higher than the levels for conventional groups--the same distance which appears between the means for the two learning conditions on the second formative test.

Corrective instruction on the second task. The initially higher levels of achievement attained by tutoring and mastery students on the second task increased through the use of corrective instruction. The scores of tutoring and mastery students on the alternate form of the second test (FT 2B) indicate that the corrective instruction enabled tutoring groups to attain mean levels of achievement which average about 50% higher than the means for conventional groups and enabled mastery groups to gain achievement levels which average about 40% higher than conventional groups.

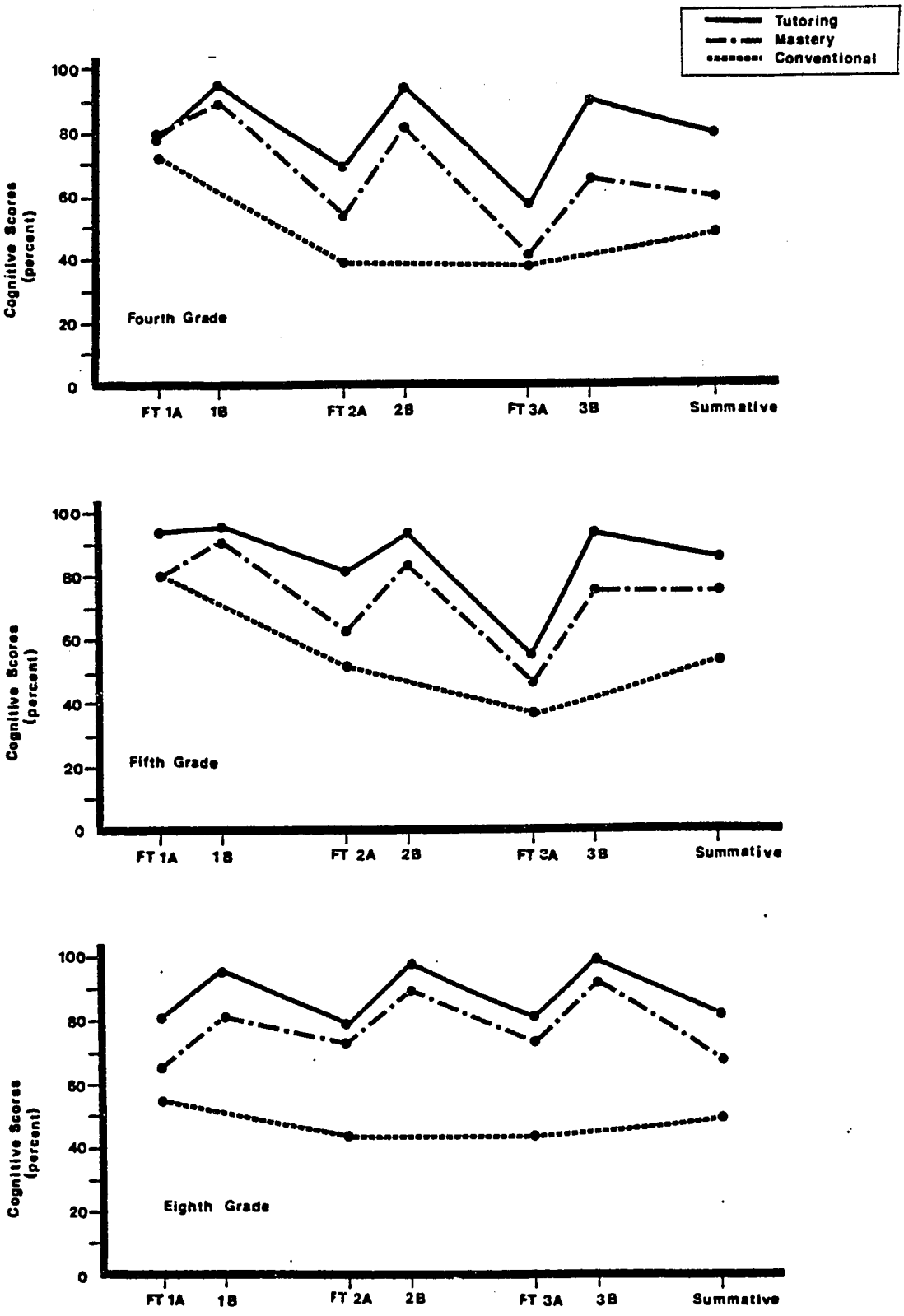

Fig. 3. Changes in Achievement Over Learning Tasks

Achievement on the third learning task

In the fourth and fifth grade studies, the third learning task was especially difficult, and the mean achievement for all groups is low. However, the pattern of higher levels of achievement for tutoring and mastery groups remains evident, and the mean achievement for fourth and fifth grade tutoring groups is an average of 19% higher than for conventional groups, while the mean achievement for mastery groups is an average of 6% higher. The eighth grade study provides the kinds of expanding distances expected between the tutoring, mastery, and conventional groups. The mean for the tutoring group is 38% higher than the mean for the conventional group and the mean for the mastery group is 30% higher.

As expected, the conventional groups show a steady decrease in level of achievement over the series of learning tasks, and the means for these groups on the third task average only about 39%. Students in conventional groups, without access to corrective instruction, found themselves entering progressively more difficult tasks with fewer and fewer of the prerequisite learnings for comprehending the instruction. In each of the studies, success in learning the final task depended heavily on having acquired a high level of learning during the previous tasks.

Corrective instruction on the third task. After corrective instruction, the levels of achievement for tutoring groups were an average of 55% higher than for conventional groups, and the levels for mastery groups were an average of 38% higher than for conventional groups. The corrective instruction provided in tutoring groups was effective in assisting almost all students to meet or exceed the 90% criterion. Corrective procedures were also effective with the fifth and eighth grade

mastery groups. However, insufficient corrective help was given in the fourth grade mastery group, and only 15% of the students met the 80% criterion set for this condition. It is likely that had the corrective instruction been further extended the majority of the fourth grade mastery group would also have met the criterion.

Summary

The data from all three studies support the hypothesis that level and variation in achievement is a function of the quality of instruction students are given. The achievement distributions we are accustomed to finding in schools are a phenomenon of the quality of instruction we traditionally provide--a quality which enables a few students to learn well, but inhibits the learning of many students. The achievement levels reached by tutoring groups indicate that students who receive a quality of instruction which is responsive to their learning needs are capable of attaining the high levels of learning which are normally attained by only a few students under conventional conditions. The data also strongly indicate the importance of a feedback/corrective component in maintaining a high quality of instruction condition and assuring that students attain the prior knowledge and skills required for succeeding with new learning. The only difference between the mastery and conventional conditions was in the provision of feedback/correctives to the mastery groups. However, this single enhancement of the quality of instruction was sufficient to enable students learning under mastery conditions to acquire higher levels of achievement with less variation than were found in conventional groups.

Effects of Quality of Instruction on Relations between Students' Cognitive Characteristics and Achievement

In addition to examining the effects of quality of instruction on achievement, the studies were also designed to examine the relations which develop between students' characteristics and their subsequent achievement under different quality of instruction conditions. The student characteristics of concern to the studies are prior achievement and aptitude. Both variables were discussed in Chapter III. Briefly, teacher grades were used as the measure of prior achievement and scores on selected batteries of the Cognitive Abilities Test as the measure of aptitude.

The literature reports strong correlations between aptitude and prior achievement and the achievement students subsequently attain (see Chapter II). The strong correlations between these student characteristics and achievement have often served as the basis for generalizations about human potential for learning, although the position taken here is that such findings would be more appropriately used as the basis for statements about the effects of prior characteristics when students learn under conventional conditions. The accumulating evidence from mastery learning studies strongly indicates that the influence of prior characteristics on achievement can be diminished by enhancing the quality of instruction available to students.

Theoretically, a quality of instruction which approximates a maximal learning condition should enable students to attain equally high levels of learning, regardless of their prior characteristics. The argument was forwarded in Chapters I and III that tutoring is potentially capable of providing a maximal quality of instruction which would enable

most individuals to attain high levels of achievement despite variations in such characteristics as prior achievement or aptitude.

In conventional conditions, relations between prior characteristics and achievement are understandably strong because the quality of instruction available to students is not altered to suit the needs of individuals and because there is no systematic means of correcting the errors in learning which frequently occur as students encounter new tasks. Students with high levels of prior achievement or aptitude for school learning would be expected to learn well under conventional conditions, but the majority of students, who possess lower levels of prior achievement or aptitude, would be expected to encounter problems with tasks and achieve less success in learning.

Weaker relations between prior characteristics and achievement should occur under mastery conditions, where the instruction is periodically adapted to individual needs and errors in learning are corrected before new tasks are introduced. The weakest relations should be found in tutoring, which adapts all components of quality of instruction to the needs of individual learners.

The second hypothesis is an elaboration of the first. It is formulated to test the influence of quality of instruction on the relations which develop between prior characteristics and subsequent achievement.

Hypothesis 2: <u>The relation between student achievement and prior measures of achievement and aptitude is determined by the quality of the instruction given the student</u>.

In the hypothesis statement, <u>relation</u> refers to the strength of the association between students' prior characteristics and their

subsequent achievement. In the fourth and fifth grade groups, where probability was taught, teacher grades for mathematics were used as the measure of prior achievement and students' scores on the quantitative battery of the Cognitive Abilities Test, as the measure of aptitude. Cartography was taught in the eighth grade study, and teacher grades for social studies were used as the measure of prior achievement, with scores on the verbal battery of the Cognitive Abilities Test serving as the measure of aptitude. Student achievement was operationalized as the level of learning exhibited on formative and summative tests.

In testing the hypothesis, correlations between prior achievement and subsequent achievement and between intelligence and subsequent achievement were examined for students learning under the three quality of instruction conditions used in each study (i.e., tutoring, mastery, and conventional). The relations found between students' prior characteristics and their summative achievement are discussed first. This is followed by a discussion of the relations found over a series of learning tasks.

Relations between Prior Characteristics and Summative Achievement

Prior achievement

In the three tutoring groups, the correlations between prior achievement and summative achievement are weak, averaging only about +.08. In contrast, correlations in conventional groups averaged about +.50, with the strongest relations occurring in the fourth grade group (r = .75). Correlations in mastery groups are also weaker than in conventional groups. Correlations between prior and summative achievement for mastery groups average about +.24, roughly half the average size found in conventional

groups. However, in the eighth grade study, the correlations for mastery and conventional groups are very similar (see Table 4).

The corrective instruction provided to mastery students after each initial formative test was expected to diminish the relations between prior achievement and summative achievement. This occurred in the fourth and fifth grade groups, where correlations for mastery groups average 38% less than for conventional groups. The corrective strategies were not as effective in diminishing the effects of prior achievement in the eighth grade. It is likely that the cues used in corrective instruction for the eighth grade mastery students relied too heavily on reading and verbal skills and did not sufficiently adapt the instruction to students who needed other kinds of explanations and practice materials in order to retain and apply the learning acquired during the corrective sessions to the problems presented on the summative test. More adaptive approaches were taken for the fourth and fifth grade mastery students by using visuals and manipulatives.

In general, the studies found lower correlations between prior and summative achievement in the conventional conditions than are usually reported. Bloom (1976) examined longitudinal studies and found an average correlation of about +.80 between the two variables. Froemel (1980) reports average correlations of +.75 for students in conventional instruction at the end of a six-month study. The lower correlations found for conventional groups in the studies reported here are probably due to the brief duration of the studies (e.g., three weeks) and to the selection of subject matter which would be relatively unrelated to the previous work students had encountered in mathematics or social studies. Neither the probability nor the cartography units would logically follow the work

TABLE 4

CORRELATIONS BETWEEN PRIOR ACHIEVEMENT AND SUBSEQUENT ACHIEVEMENT

Group	n	Prior Achievement and Achievement on Original Formative Tests			Prior Achievement and Achievement on Summative Test
		FT 1	FT 2	FT 3	
Fourth Grade					
Tutoring	20	.26	.31	.11	.14
Mastery	26	.26	.21	.06	.27
Conventional	24	.33	.41	.55	.75
Fifth Grade					
Tutoring	20	.30	.01	-.12	.11
Mastery	26	.29	.14	.33	.10
Conventional	28	.47	.48	.27	.38
Eighth Grade					
Tutoring	21	.11	.32	.45	.00
Mastery	28	.47	.03	.00	.36
Conventional	33	.51	.54	.30	.38

students had completed before the studies began. The rationale for selecting unfamiliar topics for the studies was discussed in Chapter III and will be reintroduced in the discussion of the fourth hypothesis tested during the studies. Briefly, the intent was to reduce as much as possible the effects of students' affective responses to mathematics or social studies.

The differences in the quality of instruction available to students under each learning condition are reflected in the relative strength of the relations between prior and summative achievement which develop for tutoring, mastery, and conventional groups. In conventional groups, where the relations are strong, prior achievement accounts for an average of about 25% of the variance in summative achievement. However, in tutoring groups, the relations are weak, and prior achievement accounts for an average of only 1% of the variance, and in mastery groups an average of about 6% of the variance is due to prior achievement.

Aptitude

The relations found between aptitude and summative achievement are weaker in tutoring and mastery groups than in conventional groups. Correlations average about +.31 in tutoring and about +.37 in mastery conditions. In conventional groups, the correlations average about +.61 (see Table 5).

Aptitude usually accounts for about 50% of the variance in achievement (Bloom, 1976). It accounts for about 38% of the variance in summative achievement for the conventional groups in the studies reported here. Far less of the variance in achievement can be accounted for by aptitude when students received a quality of instruction adaptive to individual learning needs. In tutoring groups an average of about 10% of the

TABLE 5

CORRELATIONS BETWEEN APTITUDE AND ACHIEVEMENT

Group	n	Aptitude and Achievement on Original Formative Tests			Aptitude and Summative Achievement
		FT 1	FT 2	FT 3	
Fourth Grade					
Tutoring	20	.50	.41	.25	.38
Mastery	26	.27	.09	.23	.44
Conventional	24	.27	.49	.47	.70
Fifth Grade					
Tutoring	20	.51	.32	.20	.37
Mastery	22	-.01	.22	-.06	.30
Conventional	28	.44	.69	.29	.55
Eighth Grade					
Tutoring	21	.40	.28	.19	.17
Mastery	28	.68	.32	.21	.42
Conventional	29	.62	.42	.55	.59

variance in summative achievement can be explained by aptitude and in mastery groups, about 15%.

Both the cartography and the probability units placed heavy demands on students' general reasoning abilities and abilities to deal with abstract concepts. In tutoring groups, the demands could be alleviated during instruction by providing individuals with the kinds of demonstrations and concrete examples which would enable them to grasp the more abstract elements of the learning task, but in conventional and mastery groups, the tasks were presented at a level of difficulty which was not adjusted to individual needs. The explanation for the differences which appear between the correlations in mastery and conventional groups is found in the differences between the quality of instruction available in the two conditions. In conventional groups, each formative test signaled the termination of a learning task. However, in mastery groups, the formative tests served a different purpose and became the basis for providing individualized assistance with specific elements of a task. The corrective instruction given to mastery students diminished the relationship between aptitude and summative achievement.

Changes in the Relations between Prior Characteristics and Achievement over a Series of Learning Tasks

In tutoring and mastery conditions, the relations between aptitude and prior achievement and the subsequent achievement of students were expected to decrease over a series of related learning tasks because students in these conditions received a quality of instruction which was adapted to their individual learning needs. However, the relations between students' prior characteristics and their subsequent achievement

were expected to increase over the series of tasks in conventional groups, where instruction was not responsive to the needs of individuals. The results pertaining to prior achievement and achievement over the series of tasks are discussed first, followed by a discussion of changes in the relations between aptitude and achievement.

Prior achievement and achievement over learning tasks

Correlations between prior achievement and achievement (see Figure 4 and Table 4) on the first learning task are an average of about 21% less for tutoring than for conventional groups. On the second task the differences in the relations which develop between prior achievement and achievement for tutoring and conventional groups increase slightly so that correlations for tutoring groups are an average of 26% less than for the conventional groups. On the third task, correlations for the eighth grade tutoring group deviate from the pattern of weaker correlations, but in the fourth and fifth grades, correlations for tutoring groups continue to be much weaker than for conventional groups.

Some fluctuation in the correlations over the series of learning tasks should be expected. Each learning task was taught during a very brief period of time, and the formative tests were relatively short (see Table 9 in appendix for test reliability information). However, despite this, a pattern of weaker relations between prior achievement and achievement for tutoring groups over the series of tasks clearly emerges from the data.

A pattern of weaker correlations for mastery than for conventional groups also emerges over the series of learning tasks. On the first learning task, correlations for tutoring groups are an average of about

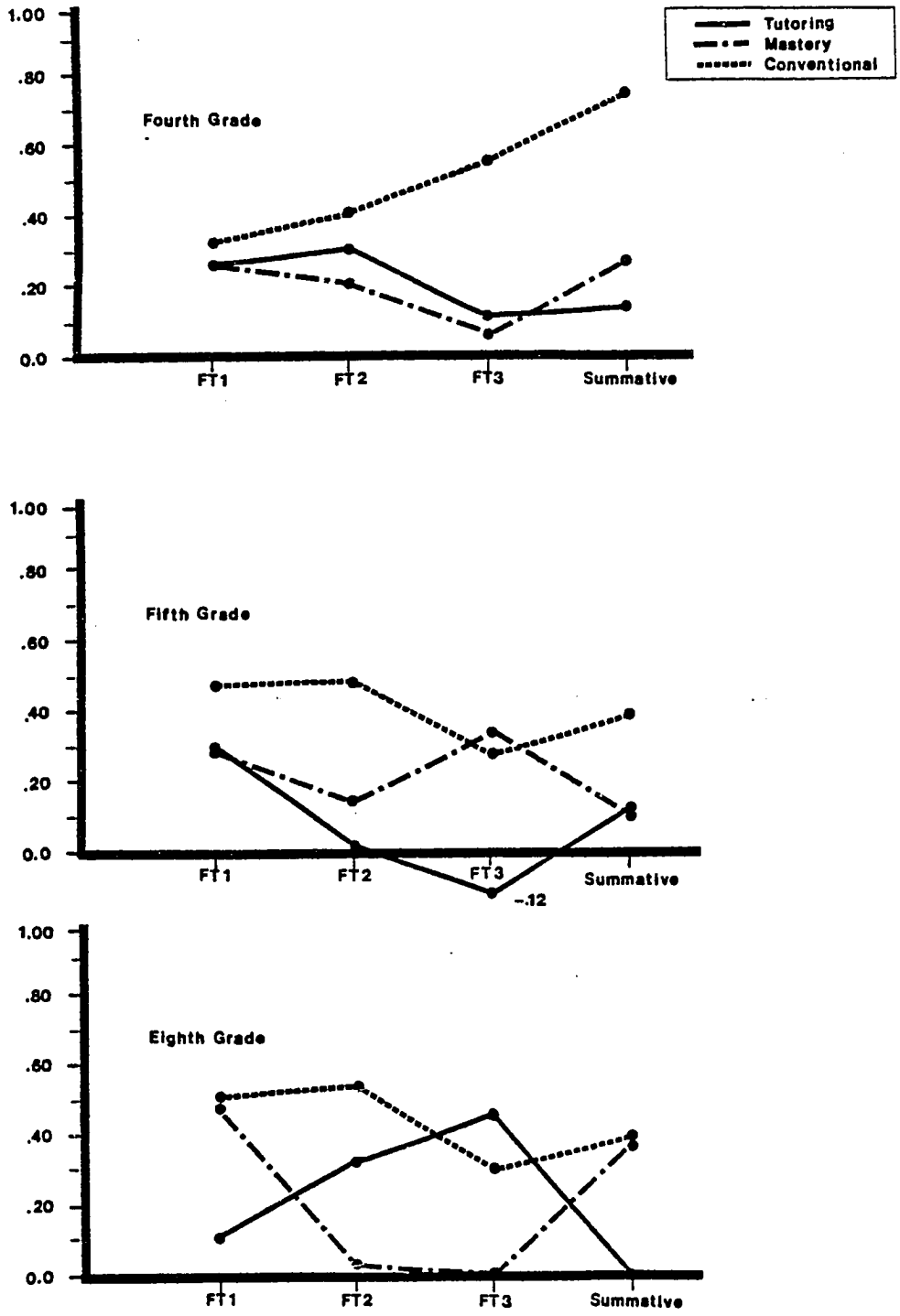

Fig. 4. Correlations between Prior Achievement and Formative and Summative Achievement

10% lower for mastery than for conventional groups. The relations for mastery and conventional groups on the first task were expected to be fairly similar because students in the two conditions received essentially the same quality of instruction before the first formative test was administered and mastery groups received feedback and correctives. On the second learning task, correlations are an average of 35% less for mastery groups. Correlations are also considerably weaker for fourth and eighth grade mastery groups on the third task, but slightly stronger for the fifth grade mastery group.

As Figure 4 illustrates, the relations which evolve between prior achievement and achievement over the series of related learning tasks are generally weaker for tutoring and mastery groups than for conventional groups. Despite the brief amount of time allowed for each learning task, differences do appear in the correlations for prior achievement and achievement for students learning under tutoring, mastery, and conventional conditions.

Aptitude and achievement over learning tasks

In each of the three studies, correlations between aptitude and achievement for the tutoring groups progressively decrease over the series of learning tasks so that by the third task the correlations for each tutoring group are only one-half or less the size of the correlations which are found for these groups on the first task. Correlations between aptitude and achievement are an average of +.47 for tutoring groups on the first task, but only +.21 on the third task. In contrast with the diminishing relations found in tutoring, the correlations for conventional groups are an average of +.44 on both the first and third learning tasks (see Figure 5 and Table 5).

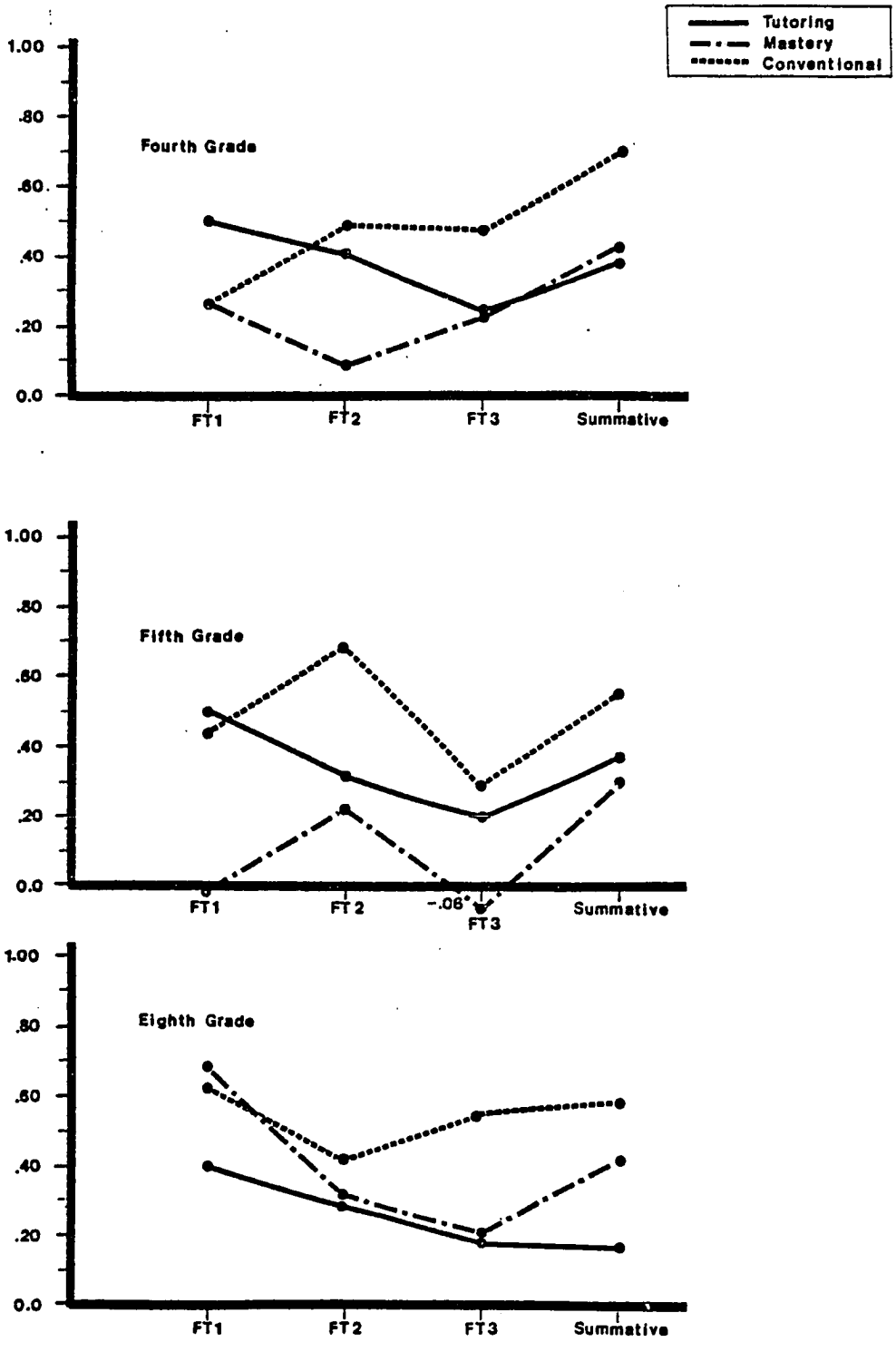

Fig. 5. Correlations between Aptitude and Formative and Summative Achievement

Although correlations for mastery and conventional groups in the fourth and eighth grade studies are similar on the first learning task, by the third task the correlations for these mastery groups are less than one-half the size of correlations for the conventional groups. In the fifth grade, where the relations between aptitude and achievement are weaker for mastery than for conventional groups on the first task of the series, weaker correlations also appear for the mastery group on the third task.

After the first learning task, the relationships between aptitude and achievement are consistently weaker in tutoring and mastery groups than in conventional groups. The differences in correlations between tutoring, mastery, and conventional groups over the series of learning tasks are illustrated on Figure 5.

Summary

The patterns of relations found between prior achievement and summative achievement and between aptitude and summative achievement are consistent for the three studies. The weakest relations occur when students receive tutoring and the strongest when students learn under conventional conditions. Weaker relations between each of the two student characteristics and summative achievement are also found under mastery learning conditions than are found under conventional conditions. When students receive a quality of instruction adapted to individual learning needs, prior achievement and aptitude have little influence on the achievement they are able to attain. However, when the instruction is not responsive to the learning needs of individuals, prior achievement and aptitude exert a strong influence on the achievement students attain.

Effects of Quality of Instruction on Engagement in Learning

In discussing the model underlying these studies, it was proposed that engagement in learning and achievement are interactive and that both are affected by the quality of instruction students receive. Engagement in learning refers to the overt and covert learning behaviors of students during a learning task, including such behaviors as responding to questions posed by the teacher, thinking about possible solutions to a problem, and attending to explanations provided by the instruction. It was operationalized as students' reports of their overt and covert time-on-task and as observed time-on-task. The studies were concerned with whether students who learn under different quality of instruction conditions exhibit differences in the extent to which they actively engage in learning.

The literature provides ample evidence that large differences in the extent to which students actively participate in learning occur among students under conventional learning conditions (see Chapter II). In general, studies of time-on-task under conventional conditions find higher levels of task involvement for students who are high-achieving than for the students with lower levels of achievement (e.g., Good & Beckerman, 1978). In summarizing the results of time-on-task studies under conventional conditions, O'Brien and Ginsburg (1980) found the median percentage of time-on-task reported by the studies to be about 65%. The variation among students in task involvement and the fairly low median level of time-on-task is understandable because conventional instruction does not incorporate a system for assuring that students acquire the cognitive entry behaviors which will enable them to benefit from further instruction. Under conventional conditions, few students enter subsequent

tasks well prepared to succeed, while the majority find that they are increasingly unable to comprehend the instruction and that their efforts to participate are not rewarded with a more adequate learning of the tasks. It is unlikely that students who lack the prerequisites for new instruction will continue directing their energies and attention to active engagement in a task which is progressively incomprehensible to them. Both the desire and the ability to become actively involved in learning would be expected to decrease.

Studies comparing time-on-task under mastery learning and conventional conditions indicate that student engagement in learning is affected by the quality of instruction they are given (see Chapter II). Students in mastery conditions are usually reported on-task from 80% to 85% at the end of a series of learning tasks (Bloom, 1976). In these studies, the quality of instruction available to mastery students is enhanced by the provision of feedback/corrective strategies which enable almost all students to enter subsequent tasks with the cognitive entry behaviors they need to be active participants in new learning. The studies also indicate that students under mastery conditions become increasingly similar in their involvement in learning, while large variation in time-on-task occurs for students in the conventional conditions.

In the studies reported here, the highest levels and smallest variation in students' engagement in learning were expected for students who received tutoring. Tutoring incorporates the feedback/correctives of mastery learning, but also provides students with initial instruction which is adapted to the learning needs of the individual. The constant interchange which occurs in effective tutorials should enable the tutor to recognize at which points in a task the student is encountering

difficulty and to quickly adjust the explanations to the student's need. It should also allow the tutor to closely monitor the amount and kind of practice a student receives, assuring that the student's desire to participate is not diminished by needless practice on what has already been learned. In addition, the reinforcements the student receives for attending to a task should be more effective because they are specific to the individual, rather than generally directed toward a group of students.

The following hypothesis was formulated to test the relation between quality of instruction and student engagement in learning.

Hypothesis 3: Level and variation in the percentage of time students are actively engaged in learning is a function of the quality of instruction students are given.

Engagement in learning refers to students' overt and covert involvement in learning. It was operationalized as observed time-on-task and as students' reports of their overt and covert time-on-task. Observations of time-on-task were made during eight class periods for each quality of instruction condition in each of the three studies. Observers used a scale developed by Good and Beckerman (1978) for coding students' task behaviors. The scale is described in Chapter III.

Students' reports of their own overt and covert time-on-task were obtained from responses to items taken from an instrument, which included both positive and negative statements about their overt and covert involvement in the learning. For example, students were asked to indicate if they had listened carefully to questions posed by the teacher, thought about something other than the subject being taught, completed their assigned work, and responded to a question raised during the class. The

students' reports were obtained at the completion of each learning task, a total of three times in each study. Reliabilities for the instrument were .67 in grade four, .66 in grade five, and .79 in grade eight. A copy of the instrument is included in the appendix.

The results for students' reports of overt and covert time-on-task are discussed first. This is followed by a discussion of observed time-on-task. After examining the levels and variations in time-on-task found between students under different quality of instruction conditions, the changes which occurred within the different conditions are discussed.

Comparison of Student Reports of Time-on-Task Under Different Quality of Instruction Conditions

At the completion of the final learning task of each of the three studies, students in tutoring reported significantly higher levels of overt and covert time-on-task than were reported by students under conventional conditions. As indicated in Table 6, the differences between tutoring and conventional students in time-on-task were significant at or above the .05 level in each study. Students who received tutoring were on-task an average of about 89% of the instructional time during the final task, but under conventional conditions, students were on-task an average of only about 66%. The higher levels of task involvement in tutoring are accompanied by smaller variations than are found in conventional conditions. Variance for tutoring conditions is an average of almost 3/4 less than the variance found for conventional conditions. At the end of the series of learning tasks, students who received a quality of instruction which enabled them to comprehend and succeed with the requirements of each task exhibit high levels of time-on-task and appear very similar in the extent of their involvement in learning. Under

TABLE 6

COMPARISON OF STUDENT REPORTS OF

OVERT AND COVERT TIME-ON-TASK

Group		Learning Task 1	Learning Task 2	Learning Task 3
Fourth Grade				
Tutoring (n = 20)	x	87.50***	89.00*	92.50***
	s	13.10**	7.18**	7.60**
Mastery (n = 26)	x	61.53	80.00	75.96
	s	22.50	12.00	21.13
Conventional (n = 24)	x	67.37	80.83	68.40
	s	23.30	14.72	23.44
Fifth Grade				
Tutoring (n = 20)	x	77.50	87.00**	83.33*
	s	23.12	20.80	17.31*
Mastery (n = 26)	x	66.67	58.46	72.12
	s	23.57	27.52	20.94
Conventional (n = 28)	x	69.65	70.00	67.86
	s	30.78	19.63	25.23
Eighth Grade				
Tutoring (n = 21)	x	93.65***	89.52***	90.48***
	s	12.33**	12.84**	13.77**
Mastery (n = 28)	x	58.65	68.89*	73.46*
	s	32.80	23.26	22.18
Conventional (n = 33)	x	66.17	58.48	60.86
	s	28.72	24.38	27.13

In the fifth grade study, the mean for the conventional group on the second task was significantly higher at the .05 level than the mean for the mastery group, and the variation for conventional was significantly different from mastery at the .05 level.

conventional conditions, levels of time-on-task are much lower, and students vary greatly in the extent of their involvement in learning.

Differences in the mean levels of time-on-task for students under mastery and conventional conditions were also found during the final learning task. Students under mastery were on-task an average of about 74%, in comparison to the average of 66% for conventional students. Variation in time-on-task under mastery conditions was consistently smaller than under conventional conditions for each of the studies. Variance in time-on-task under mastery conditions is an average of one-fourth less than under conventional conditions.

The high levels of time-on-task and small variations under tutoring and mastery conditions were expected. Students under tutoring had immediate access to a teacher whenever they had a question or needed additional assistance. They were able to obtain the help they needed to maintain active involvement in learning during the instructional sessions. Under tutoring, students also received feedback/correctives which assured that they entered each successive task with the cognitive behaviors essential to comprehending and participating in the lessons. The differences in involvement between mastery and conventional groups can be explained by the availability of feedback/correctives to mastery students. At the completion of each learning task, the learning problems of mastery students were identified, and students received individual assistance in correcting mistakes in their original learning. As a result of this process, mastery students entered new tasks with the prerequisites for active and productive involvement in learning.

In addition to the obvious function of the feedback/corrective procedures, that of enabling students to reach high levels of learning before proceeding to new tasks, it is likely that what occurs during the

procedure serves to increase student motivation for further engagement in learning. Regardless of how individuals in tutoring or mastery fared during the initial instruction or performed on an initial formative test, the feedback/correctives enabled almost all to obtain evidence that they had learned well and were capable of successfully meeting the demands of the task. This evidence was obtained from their achievement on an alternative version of the initial test. As high levels of learning were reached on each task, the student would be expected to develop a more positive concept of ability to learn and stronger motivation for active engagement in further learning.

In contrast with the quality of instruction available to students under tutoring and mastery conditions, students under conventional conditions did not receive instruction adapted to the learning needs of individuals. The majority of the students under conventional conditions had not acquired the kinds of prerequisite learnings they needed to comprehend the final learning task, and this is reflected in the lower levels of time-on-task and larger variations found for these students.

The explanation which has been offered for the differences found in time-on-task between tutoring and conventional and between mastery and conventional has focused on the results at the end of the series of learning tasks. An examination of the task behaviors reported by students under different conditions on the initial task should serve to further support the explanation.

Initial learning task. Differences in the mean levels of time-on-task for tutoring and conventional students appeared during the first task. The means for tutoring in each study were higher than for conventional, and in the fourth and eighth grade studies the differences were

significant at the .001 level (see Table 6). The greater initial involvement in learning by students under tutoring can be accounted for by the quality of instruction the students were given. In tutoring, instruction was adapted to the needs of individuals during the initial presentation of the task. This kind of attention to individual learning needs is not possible under conventional conditions. The initial time-on-task under mastery and conventional conditions was similar. Students in the two group-based conditions were expected to have similar levels of on-task behaviors during the initial task because time-on-task was measured before changes were made in the quality of instruction available under the two conditions. The mastery group had not yet received the feedback/correctives.

Observed time-on-task under different quality of instruction conditions

The mean levels of observed time-on-task found for students under all learning conditions were unusually high, particularly in the fourth and fifth grade studies. During the third learning task of each of the three studies, students under tutoring were observed to be on-task about 100% of the time, under mastery an average of 91%, and under conventional an average of 79% (see Table 10 in appendix). Very high levels of observed time-on-task were expected for the tutoring conditions. Tutors could respond immediately to any problem an individual encountered in learning and could redirect attention to the task as needed. In the eighth grade tutoring, where each tutor was responsible for only one student, no student was ever coded off-task during the entire study. Considering the student to teacher ratio in the eighth grade tutoring, the observed time-on-task results are understandable.

However, the exceptionally high levels of time-on-task observed in the fourth and fifth grade mastery and conventional conditions raise questions about how accurately the observed behavior represented students' actual engagement in learning. In the fourth and fifth grades, means for time-on-task under mastery were 90% or above and means under conventional conditions were 83% or above throughout the series of learning tasks. Only the results for the eighth grade mastery and conventional groups approximate the levels of time-on-task reported by other studies (e.g., Anderson, 1973; Hecht, 1977).

The studies took place in a parochial school where discipline was strictly enforced. Instances of misbehavior or other kinds of observable off-task behaviors were extremely rare. It seems likely that the high levels of observed time-on-task provide an inflated view of students' engagement in learning.

Although observed time-on-task was unusually high, the patterns of mean levels of observed time-on-task under the different learning conditions duplicate the patterns of overt and covert time-on-task which were reported by the students (see Table 6 and Table 10). The more moderate levels of task behaviors reported by students are believed to offer a more realistic view of the students' engagement in learning, and these reports are used in discussing how students' task behaviors changed within the three different instructional conditions during the studies.

Changes in student reports of time-on-task within different quality of instruction conditions

The levels of time-on-task for students under tutoring conditions during the first learning task are high, with the highest mean of about 94% found in the eighth grade tutoring, where students received one-on-one

tutoring throughout. Under tutoring, the mean levels of time-on-task either remained at high levels or increased further over the series of learning tasks. Figure 6 illustrates the changes which occurred within each learning condition.

In each of the tutoring conditions, variation in time-on-task among students either remained low throughout, as in the eighth grade study, or decreased, as in the fourth and fifth grade studies. Variance decreased by almost 2/3 in the fourth grade tutoring and by more than 2/5 in the fifth grade tutoring condition.

As Figure 6 indicates, mean levels of time-on-task increased from the first to the final task for all mastery groups by an average of about 19%. Variation within mastery conditions decreased from the first to the final task (see Table 6). The greatest decrease in variation occurred within the eighth grade mastery condition, where the variance on the final task is 1/2 less than for the first task.

Under the tutoring and mastery conditions, levels of time-on-task increased while variation decreased over the series of learning tasks. Instruction was adapted in ways which enabled students to become successful learners and to develop confidence in their ability to learn. Students responded to the quality of the instruction they received with high levels of active engagement in learning.

During the first learning task, students under conventional conditions were an average of about 68% on-task, slightly higher than the average for mastery students. However, unlike students under mastery, students under conventional conditions did not receive the feedback/ corrective strategies which would have enabled the majority of students to attain prerequisite learnings for the next task as well as increased

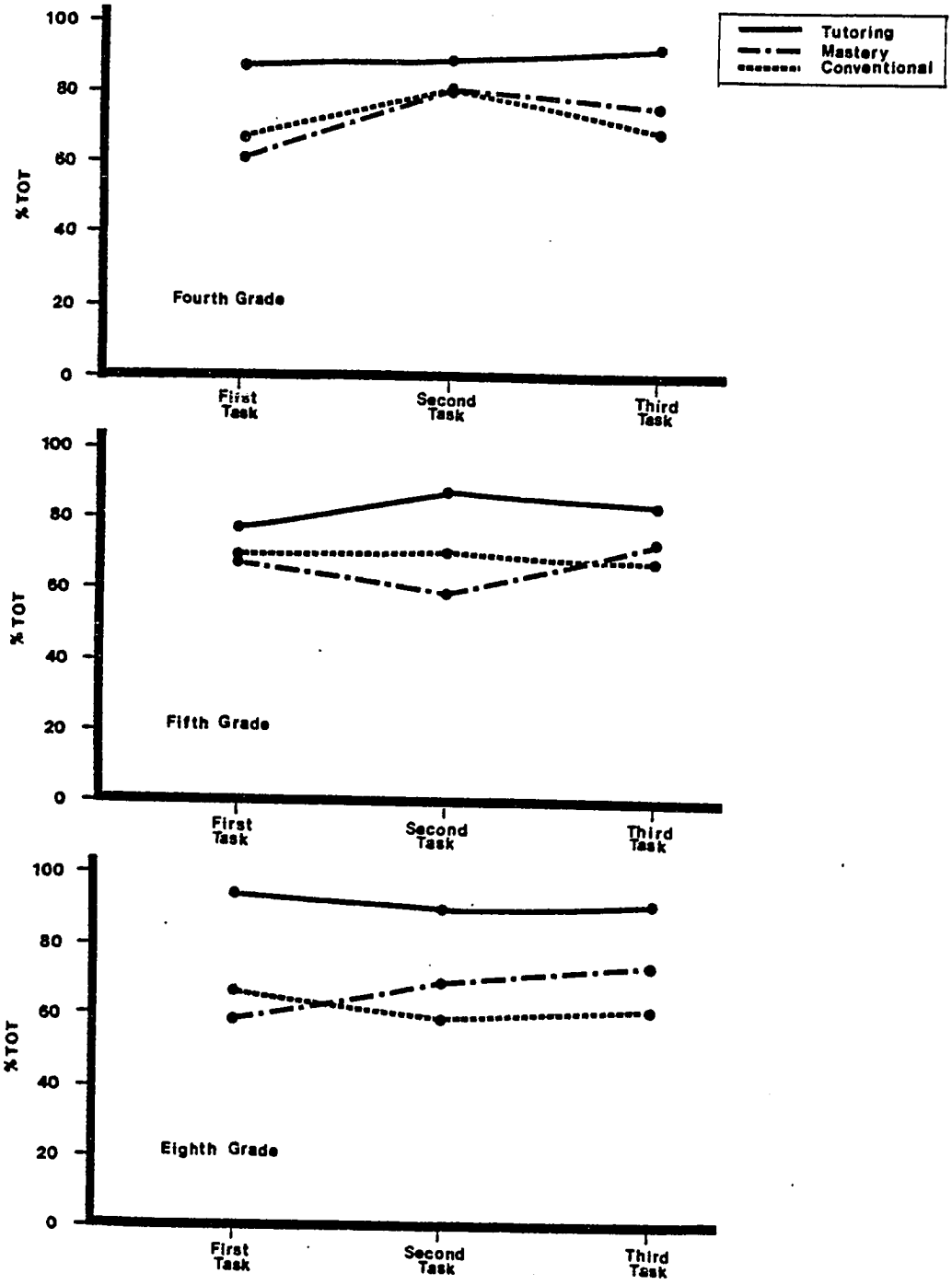

Fig. 6. Changes in Student Reports of Time-on-Task Over a Series of Learning Tasks

confidence in their ability to learn. Although time-on-task increased for mastery students from the first to the final task, it decreased under conventional conditions by an average of about 3%. Levels of time-on-task remain comparatively low and variations relatively large from the first to the final task for the conventional groups. As students under conventional conditions progressed through the series of tasks without having attained the necessary cognitive entry behaviors, they became less involved in learning and increasingly dissimilar in their task relevant behaviors.

Summary

The effects of quality of instruction are significant and immediate in these studies. The highest levels and smallest variations in time-on-task were found for students who received tutoring, a maximal quality of instruction. The lowest levels and largest variations were found for conventional groups, after the first learning task. Once mastery students begin receiving feedback/correctives, they attain levels and variations in time-on-task which indicate more effective use of learning time than is found in conventional conditions.

Students under the three quality of instruction conditions were initially similar in prior achievement and, with one exception, in aptitude (refer to Table 2), but they became very different in the extent of their active engagement in learning during the brief, three-week period of each study. Levels of time-on-task were high throughout for students who received tutoring. Students under tutoring received initial instruction which was adapted to individual needs and feedback/correctives which provided minor adjustments to assure that students attained prerequisite learnings and increased confidence in their ability to learn

successfully. The initial instruction students under mastery and conventional received was similar, and the time-on-task levels for students in these conditions were similar on the first task. However, by the end of the series of tasks, mastery students had higher levels of time-on-task and were more alike in their involvement in learning. Students under mastery received feedback/correctives over each learning task which enabled them to enter new instruction with prerequisite learnings and to gain confidence in their ability to learn. Students under conventional conditions were not assisted with individual learning problems, and their levels of task involvement either remained relatively low or decreased further over the series of tasks.

Relation between Students' Achievement and Perception of Achievement and Their Affect toward Learning

The final problem examined by the studies involves the development of subject-specific affect toward learning. Subject-specific affect refers to the attitudes and interests students report about the subject and about their willingness to continue learning it. For example, students who develop positive attitudes and interest toward a subject should view the subject as important, indicate that they find the learning enjoyable, and want to do more work with the subject. In introducing the studies, two questions were posed: Are the interests and attitudes which students develop toward learning a reflection of their achievement and of the way they perceive themselves as learners? Can attitudes and interests toward a school subject be altered by more effective instructional conditions?

Correlations between subject-specific affect and achievement generally range from +.20 to +.40 (Bloom, 1976). Although the literature provides conflicting assertions about the direction of causality between

affect and achievement (see Chapter II), Bloom's summary of findings from mastery learning studies indicates that correlations between interest in learning a subject at the beginning of a series of learning tasks and summative achievement are very weak, a median of +.06. In comparison, correlations between achievement at the end of a learning task and interest for the subsequent learning task reach a median of +.30. Also, the interest at the completion of the series of tasks and summative achievement typically reach a correlation of about +.30. These comparisons strongly suggest that achievement influences affect, while affect has only a weak effect on subsequent achievement.

The model discussed in Chapter III posits students' perceptions of their achievement as an important variable in the relation which develops between affect and achievement. Attitude and interest in learning may in part develop from the objective evidence students receive about the level of success they have attained in learning. However, it is believed that attitude and interest also evolve from the extent to which students perceive of their learning as adequate. Bloom (1971) has proposed a causal relation between students' perceptions of the adequacy of their learning of a specific learning task and the affect they develop toward the task. He also argues that the perceptions are derived from comparisons students make between their own achievement and the achievement of others in their immediate learning environment. Theoretically, students who are successful with the content and skills of a learning task and who perceive themselves as successful should develop positive attitudes and interest toward the task. Attitude and interest among students who achieve little success with the task and do not perceive their learning as adequate should be relatively low.

Mastery learning studies indicate that when students receive a quality of instruction enabling the majority of students to succeed in learning they develop more positive attitudes and interest in learning than is found for the majority of students receiving conventional instruction. In the studies here, the highest levels of positive attitude and interest are expected for students in tutoring, which provides a quality of instruction approaching the maximal for individual students.

The following hypothesis was formulated to test the relations between achievement, perception of achievement, and affect toward learning.

Hypothesis 4: Affect toward learning develops as a function of the achievement students attain and of their perception of the adequacy of their achievement.

The studies were concerned with the development of subject-specific affect (attitude and interest). Affect toward learning refers to whether students think it is important to learn the subjects taught during the studies, whether they enjoy learning the subjects and whether or not they want to continue with the learning. Affect was operationalized as students' responses to items taken from an instrument (see Appendix B) which included both positive and negative statements about the subject they were studying. Reliabilities for the combined attitude and interest instrument were .74 for grade four, .77 for grade five, and .81 for grade eight. Additional information about the instrument is included in Chapter III.

The phrase perception of the adequacy of their achievement refers to the subjective judgments made by students about the level of learning

they attain. Perception of achievement was operationalized as students' responses to items taken from an instrument which required students to indicate how well they thought they were learning, to compare their work with the work of their classmates, and to project how their learning was viewed by others. Reliabilities for the perception of achievement instrument were .67 for grade four, .64 for grade five, and .80 for grade eight. The instrument is described further in Chapter III, and a copy of it is included in the appendices.

In each study, two of the variables, subject-specific affect and perception of achievement, were measured during the same instructional period, on the day preceding the administration of a formative test. The two variables were measured a total of three times during each study. However, because of the brevity of the studies, the focus in analyzing the data is primarily on data collected during the first and final weeks of each study. The development of affect was examined for two different subject areas in three different grade levels. Affect toward probability (mathematics) was studied in grades four and five under tutoring, mastery, and conventional conditions, and in grade eight, affect toward cartography (social studies) was studied under the three learning conditions.

Effects of achievement and perception of achievement on student affect toward learning

The initial measure of affect was administered before students had received objective evidence of their achievement. As Table 7 reports, the correlations between initial affect and achievement on the first learning task are extremely weak at each grade level. The median correlation is only -.02. However, by the time students responded to the final measure of attitude and interest, they had received information

TABLE 7

RELATIONS BETWEEN ATTITUDE AND INTEREST, PERCEPTION OF ACHIEVEMENT, AND ACHIEVEMENT DURING THE FIRST LEARNING TASK AND AT THE END OF A SERIES OF LEARNING TASKS

Grade Level Groups	Relations During First Task				Relations at End of Series of Tasks			
	Achievement and Affect	Achievement and Perception of Achievement	Perception of Achievement and Affect	Multiple R Affect:: Perception of Achievement and Achievement	Summative Achievement and Affect	Summative Achievement and Perception of Achievement	Perception of Achievement and Affect	Multiple R Affect:: Perception of Achievement and Summative Achievement
Fourth (n = 70)	-.02	.27	.35	.37	.19	.28	.55	.55
Fifth (n = 74)	-.07	.28	.26	.30	.07	.22	.25	.25
Eighth (n = 82)	.03	.32	.27	.28	.30	.60	.64	.65
Median	-.02	.28	.27	.30	.19	.28	.55	.55

Correlations for the first task are based on measures administered at the end of the first task. Correlations for the end of the series of tasks are based on measures of affect and perception of achievement at the end of the tasks and summative achievement.

about their level of achievement from the results of formative tests administered at the completion of the first and second learning tasks. The median correlation between affect at the end of the series of learning tasks and summative achievement is +.19. The greatest change occurs in the eighth grade, where the correlation between summative achievement and affect at the end of the series of tasks is +.30 considerably stronger than the correlation of +.03 found between achievement and affect for the first task.

The initial measure of perception of achievement was administered concurrently with the measure of affect. During the first task, the median correlation is +.27. However, the median correlation increases to +.55 when both perception and affect are measured at the end of the series of learning tasks. The students' initial perceptions of achievement were formed in the absence of any objective evidence of the adequacy of their learning. During the period intervening between their initial reports of perception of achievement and their final reports, the students received test results which would be expected to modify the original judgments they had formed about their success in learning. As they received more information about how well they were learning, their perceptions of achievement became more closely related to the kinds of attitude and interest they developed toward the learning.

Support for hypothesizing that affect for learning evolves from achievement and perception of achievement is provided by the multiple correlations for the fourth and eighth grade studies. In the fourth grade, achievement and perception of achievement account for only 14% of the variability in affect during the first task but for 31% on the variability in affect during the final task. The changes which occur in the

eighth grade study are even more striking. In the eighth grade, achievement and perception of achievement account for only 8% of the variability in affect on the first task but for 42% of the variability in affect on the final task. In the fifth grade, there is little change in the relations between variables over the series of learning tasks.

Effects of achievement on perception of achievement. Theoretically, achievement should influence the students' perceptions of achievement and this should be reflected in increasingly strong correlations between the two variables over a series of learning tasks. The findings of the eighth grade study provide the kind of results which were expected. The correlation for achievement and perception of achievement on the first task is +.32, but the correlation is +.60 for summative achievement and perception of achievement at the end of the series of tasks. However, in the studies using fourth and fifth graders, the relations between achievement and perception of achievement remained fairly stable over the series of tasks, with achievement accounting for an average of no more than 8% to 6% of the variation in perception of achievement. It is possible that had the studies continued for longer than three weeks the effects of achievement or perception of achievement for fourth and fifth grade students would have been more pronounced.

Predicting affect for learning. In the three studies, the correlations between student perception of achievement and affect toward learning were stronger than the relations between their achievement and the affect they reported. An average of about 26% of the variation in students' affect at the end of the series of learning tasks can be accounted for by their perceptions of their achievement, alone. In comparison, summative achievement accounts for only about 4% of the variation in

final affect. The results as summarized on Table 7 strongly suggest that once the students' perceptions of their own achievement are known, knowledge of the achievement they actually attained makes little additional contribution to predicting the affect they will profess for learning.

Development of affect for students learning under different quality of instruction conditions

In introducing the fourth hypothesis, a question was raised about whether affect for learning could be altered by more effective instructional conditions. If the quality of instruction students receive alters the achievement they attain, it should follow that the highest levels of perception of achievement and positive affect would be found under conditions which enable almost all students to attain high levels of learning.

As reported in discussing the first hypothesis of the studies, the highest levels of summative achievement were attained by students who received tutoring and the next highest by students in mastery conditions (refer to Table 3). The mean levels of perception of achievement for students in the three different learning conditions during the initial task, before students had taken the first formative test, and at the end of the series of learning tasks are reported on Table 8. The initial perceptions of achievement are very high for all groups, with the lowest level of 77% found in the eighth grade conventional group. The final measure of perception of achievement was administered after students had taken tests over the first and second learning tasks, and as Table 8 indicates, the highest levels of perception of achievement at the conclusion of the series of tasks are found in tutoring groups, an average

TABLE 8

COMPARISON OF AFFECT AND OF PERCEPTION OF ACHIEVEMENT AT THE BEGINNING AND AT THE END OF A SERIES OF RELATED LEARNING TASKS

Groups		Initial Perception of Achievement	Final Perception of Achievement	Initial Affect	Final Affect
Fourth Grade					
Tutoring (n = 20)	x	90.00*	81.50**	76.67	82.50*
	s	13.20	14.61	23.20	14.85**
Mastery (n = 26)	x	82.69	71.92	73.08	67.79
	s	20.33	17.89	29.47	30.04
Conventional (n = 24)	x	81.25	65.83	75.69	68.75
	s	18.43	20.41	26.91	31.06
Fifth Grade					
Tutoring (n = 20)	x	96.88**	81.50*	65.83	81.25**
	s	7.98**	17.85	33.54	21.27*
Mastery (n = 26)	x	86.06	78.08	57.05	57.21
	s	17.08	17.21	35.02	32.82
Conventional (n = 28)	x	85.71	71.79	61.90	59.82
	s	19.46	18.87	31.38	31.06
Eighth Grade					
Tutoring (n = 21)	x	94.64***	80.48***	65.87***	80.95***
	s	9.33	12.03	34.35	24.88
Mastery (n = 28)	x	89.29**	69.64**	44.64	51.79
	s	12.60**	22.36	35.44	38.75
Conventional (n = 33)	x	76.52	52.12	32.83	40.53
	s	21.82	24.59	29.01	28.99

Levels of significance are indicated between tutoring and conventional and between mastery and conventional. A one-tailed test was used to determine differences in means, and an F ratio was computed to determine differences in variance.

* $p < .05$
** $p < .01$
*** $p < .001$

of about 81%. The next highest levels are found under mastery conditions, an average of about 74%, and the lowest in conventional conditions, where the average is about 63%. The pattern which emerges for perception of achievement under different learning conditions (see Figure 7) essentially replicates the pattern reported earlier for achievement under different learning conditions (refer back to Figure 3).

If the quality of instruction students receive alters their achievement and perception of achievement, it should also be capable of altering the affect students develop toward learning. Differences should be found in the mean levels of positive affect reported by students who learn under different quality of instruction conditions.

Effects of quality of instruction on affect

The highest levels of positive attitude and interest toward the subjects taught during the studies occurred for students receiving tutoring (see Table 8 and Figure 7). In each study, the level of affect reported in tutoring conditions increased on the final measure while the variance decreased. Students who received tutoring reported the highest levels of attitude and interest at the end of the series of learning tasks, and they became more alike in the kind of affect they developed toward learning. Table 8 provides means and standard deviations for affect at the beginning of the series of learning tasks and at the end. As indicated on Table 8, students in tutoring reported significantly higher levels of attitude and interest than did students in conventional conditions.

The results of the eighth grade study provide the strongest support for asserting that quality of instruction is capable of altering the

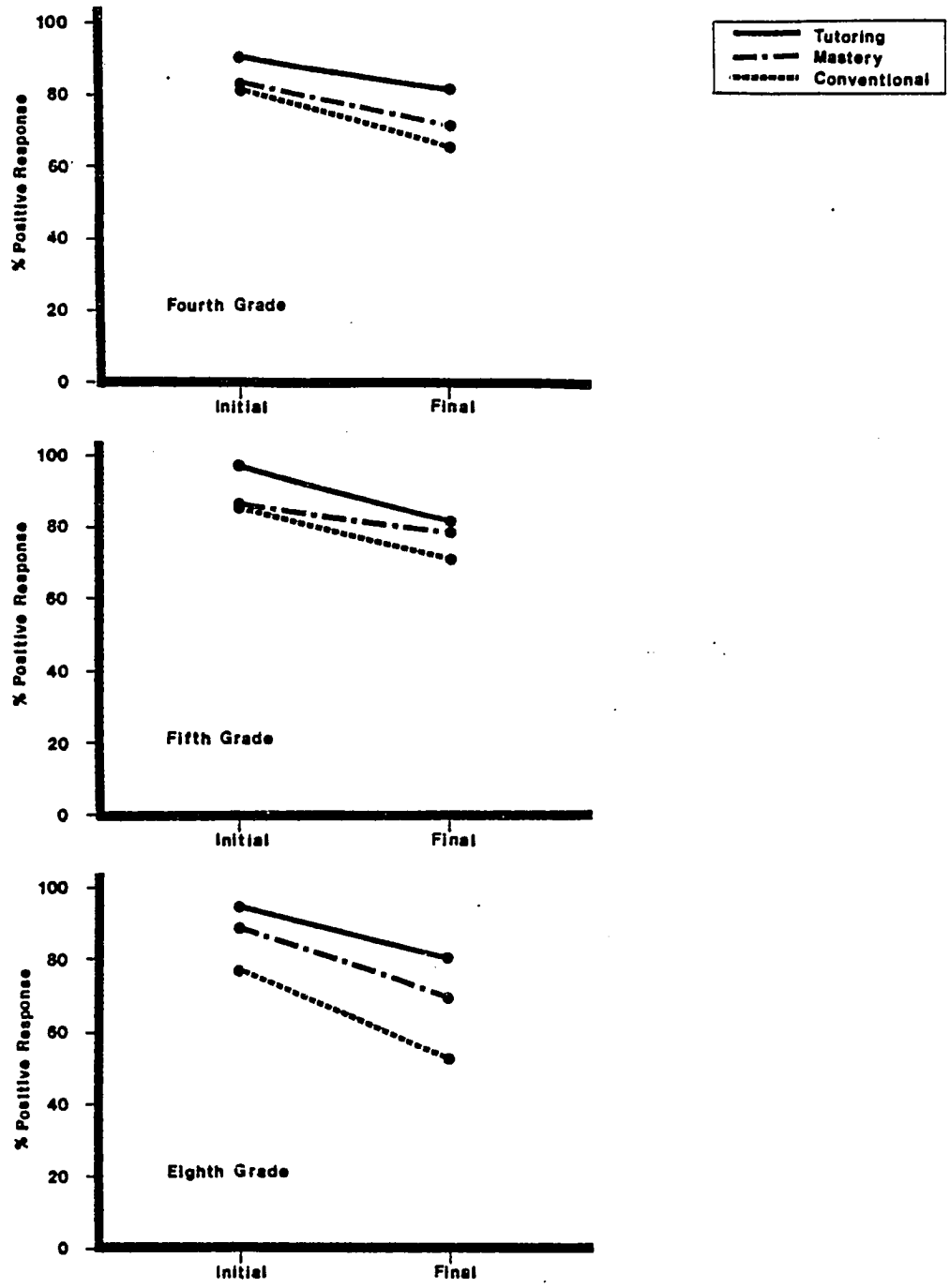

Fig. 7. Changes in Perception of Achievement Over a Series of Related Learning Tasks

affect students develop toward learning. In this study, students in both tutoring and mastery conditions reported more positive affect than did either the conventional group as a whole or the highest-achieving 20% of the conventional students. Figure 8 illustrates the changes in affect which occurred both within and between different quality of instruction conditions from the initial to the final reports made by students.

In the fourth and fifth grade studies, mastery students did not report the levels of positive affect which were expected. In these two studies, levels and variation are very similar for mastery and conventional groups (see Table 8). It is possible that requiring the fourth and fifth grade mastery students to maintain a criterion of 80% correct placed too much pressure on them. This may explain why they responded with less positive reports of affect than are normally found for mastery students. Block's (1970) work in establishing optimal criterion levels for maintaining positive affect used junior high school students.

Summary

The results of the studies indicate that the affect students develop toward learning emanates from their achievement and their perception of the adequacy of the achievement. The relation between affect and perception of achievement is particularly strong. The results for all tutoring groups and for the eighth grade mastery group also suggest that when the quality of instruction students receive alters their level of achievement, this in turn alters the affect they develop toward learning.

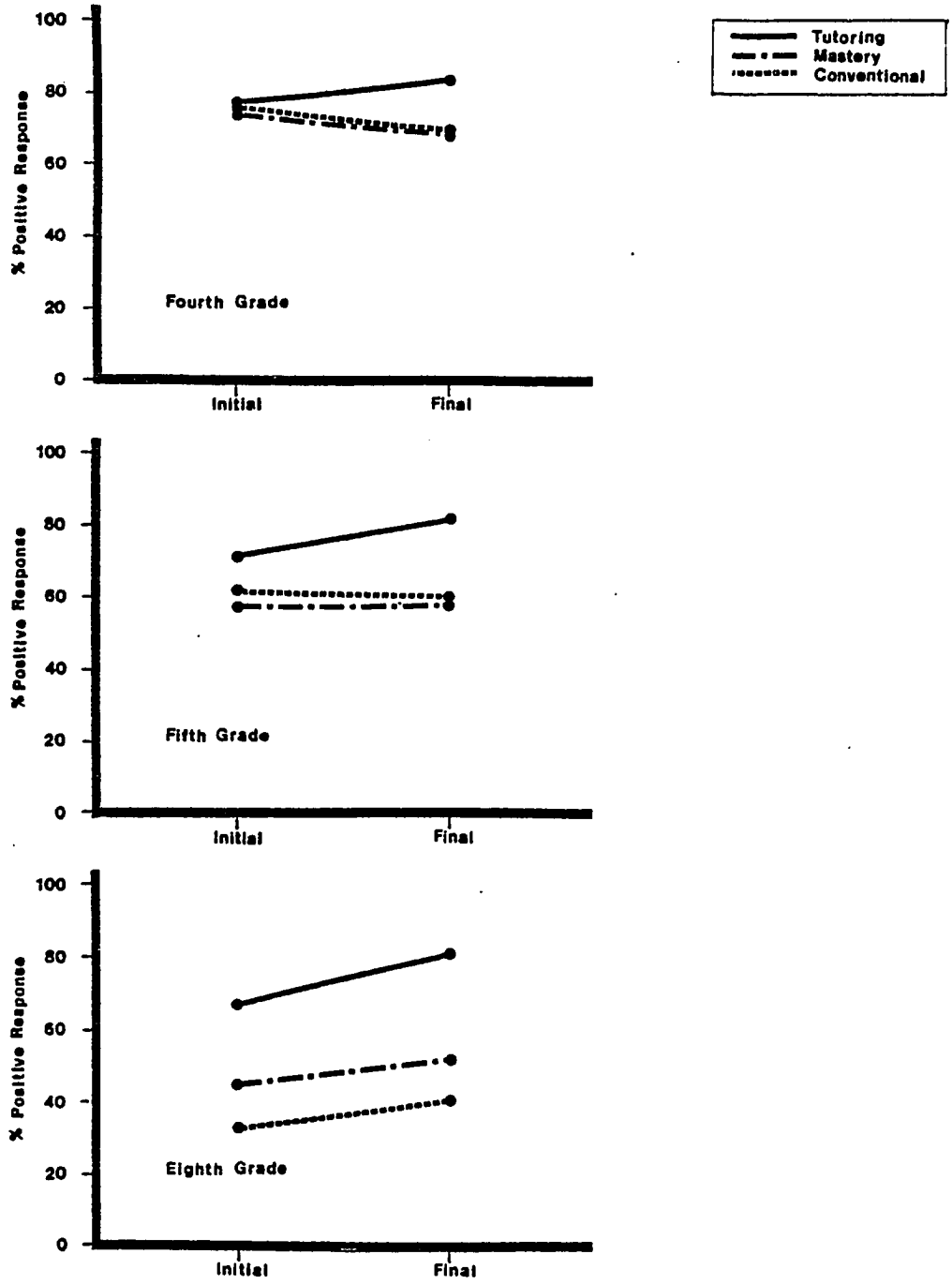

Fig. 8. Changes in Affect Under Different Quality of Instruction Conditions

CHAPTER V

SUMMARY AND IMPLICATIONS

The studies reported here examined the degree to which the learning outcomes students attain are a function of the quality of instruction they receive. The cognitive and affective learning of students was investigated under three different quality of instruction conditions: (a) tutoring, a maximal quality which adapts each component of quality of instruction to the individual, (b) conventional group-based instruction, a minimal quality which is least adaptive to individual learning needs, and (c) mastery learning, a quality which lies between the two extremes exemplified by tutoring and conventional instruction. The studies also examined the relations which evolved between initial student characteristics (i.e., aptitude and prior achievement) and the achievement students subsequently attained under different quality of instruction conditions.

Most of what is known about the effects of instruction on the cognitive and affective learning of individuals has been gained from research on students receiving conventional group instruction. Conventional group instruction cannot provide optimal qualities of instruction for all members of the group because of differences in the cognitive and affective entry characteristics of the students. Conventional instruction is not designed to enable most of the students to attain high levels of achievement and positive affect toward learning.

Group-based instruction is an economic necessity for any society attempting to educate a large segment of its population. However, it is not an appropriate context in which to determine the full extent of what individual students are capable of learning. As Bloom (1976) has noted, "we can only determine the full limits of what the student can and will learn when we have provided qualities of instruction which are optimal for the individual learner" (p. 136).

There is considerable evidence that under conventional group instruction the degree of academic success which a student will attain is largely predictable on the basis of such individual characteristics as aptitude and prior achievement. This phenomenon has been well documented in schools around the world (Walker, 1976; Wolf, 1977) and has been used to support a variety of positions. The report of the Carnegie Council on Children (deLone, 1979), for example, accepts the relationship as an inevitability of the existing social system and recommends sweeping changes in social and economic structures. Such political interpretations neglect findings which have shown this phenomenon in countries with extreme philosophical, political, and cultural differences. They also direct attention away from the teaching-learning process by implying that solutions to the inequities in learning outcomes lie outside the domain of schools and educators.

The relationship between learning outcomes and prior characteristics can no longer be accepted as an inevitability. The accumulating evidence generated by mastery learning studies has established that about 80% of the students are able to attain high levels of learning when the instruction is adapted to their learning needs through the use of feedback/corrective procedures. The results of mastery learning studies

are a major advance in our understanding of the effects of quality of instruction on learning outcomes. However, under mastery learning, the adjustments for individual learning needs are made after the initial instruction on each learning task. Many of us now believe that in addition to making effective use of feedback/corrective procedures it is also possible to greatly improve the initial instruction students receive on each learning task.

Tutoring has the potential for providing a maximal learning condition. When a student is tutored, each component of quality of instruction can be adapted to the individual. If the student lacks prerequisite cognitive entry behaviors, instruction can be immediately adjusted to enable the student to learn, despite the individual's history with similar tasks. If the student's responses indicate a misunderstanding or confusion, the explanations or cues can be made more appropriate and additional practice can be provided at once. Because the focus is on the needs of an individual learner, reinforcements can be tailored to maintain the indivdual's active participation in learning. When the immediacy of adjustments in the initial instruction is supplemented with systematic feedback/correctives, the quality of instruction available to the student should become optimal for the individual's learning needs.

The central question of the studies is: Are the cognitive and affective outcomes students attain a function of the quality of instruction they are given? The studies are also concerned with whether qualities of instruction which are adaptive to individual learning needs alter the relation between initial student characteristics and subsequent achievement. In addition, the studies examine several related questions: (a) Will students who learn under different quality of instruction

conditions exhibit differences in the extent to which they actively engage in learning? (b) Are the interest and attitudes which students develop toward learning a reflection of their achievement and of the way they perceive themselves as learners? Can these interests and attitudes be altered by more effective instructional conditions?

The Model

In the model underlying these studies, instruction is viewed as intervening between such individual characteristics of students as aptitude and prior achievement and the cognitive and affective outcomes they attain. Instruction is assumed to involve a qualitative continuum which ranges from minimum to maximum, depending on the availability and appropriateness to the individual of cues, reinforcement, participation, and feedback/correctives. A wide variety of instructional conditions lie along this continuum, from instruction consisting primarily of cues directed toward only one group of learners in a classroom to instruction which systematically enhances each of its components to the needs of individual learners. Quality of instruction is the prime variable of the model.

When students are given instruction of a minimal quality, the levels of achievement they will reach are largely predictable on the basis of aptitude and prior achievement because the instruction has no systematic means for correcting individual errors in learning or for assuring that most students acquire the cognitive entry behaviors they need to benefit from the instruction. In a maximal condition, all qualities of instruction are adapted to the needs of the individual, and learning is systematically assessed and corrected as needed. These procedures enable the student to enter each successive learning task with an optimal level

of prerequisite cognitive and affective behaviors and to complete each unit with a high level of achievement.

The model also proposes that both time-on-task and achievement are dependent on the quality of instruction. The mean percentage of time-on-task in a minimal quality of instruction condition is expected to be low, with large disparities between the on-task behaviors of high and low achieving students. Maximal qualities of instruction, with their concentration on the needs of individuals should affect the student's ability and desire to actively engage in learning. As a result, students under maximal learning conditions should exhibit high levels of time-on-task.

Following the model, an interactive relationship is posited between achievement, perception of achievement, and affect toward learning. High levels of academic success are accessible to only a few students under minimal instruction, leaving many to perceive of themselves as less capable of learning and of meeting a criterion for success. Perceptions of inadequacy as a learner lead to apathetic or negative affect toward learning, resulting in lower levels of achievement and perception of achievement. However, when the quality of instruction is maximal, almost all students should attain the highest levels of achievement and perceive of themselves as successful, academically capable individuals. This should, in turn, result in more positive affect toward learning.

The relationships between quality of instruction and the cognitive and affective outcomes students attain are expected to change over a series of sequential learning tasks. As students in minimal quality conditions enter successive tasks, their achievement should either remain at a low level or decrease even further, and this should be accompanied

by decreasing levels of time-on-task and affective entry characteristics. In contrast, under maximal quality conditions (tutoring), students should develop increasingly high levels of on-task behaviors and affective entry characteristics as they progress through the learning tasks.

According to the model, students in mastery groups would be expected to exhibit levels of achievement, perception of achievement, time-on-task and affect which are similar to students in conventional instruction for the first learning task. However, because instruction in the mastery groups is periodically individualized through the use of feedback/corrective strategies, students under mastery conditions should attain increasingly higher levels of achievement, positive perception of achievement, time-on-task, and positive affect on successive learning tasks.

Design

The studies were undertaken to examine the effects of the quality of instruction students receive on the cognitive and affective outcomes they attain. Three different quality of instruction conditions were used in each of the studies: tutoring, which approximates a maximal condition, conventional, which approximates a minimal condition, and mastery learning, a condition which is viewed as falling between the two extremes.

Three studies were conducted, using three different grade levels and two different content areas. Students in grades four and five were taught probability under tutoring, mastery, and conventional conditions. Students in grade eight were taught cartography under the different quality of instruction conditions. Eighth grade students in the maximal condition received one-on-one tutoring, while students in the fourth and fifth grade maximal conditions were tutored by teachers who were

responsible for instructing three students each. All students assigned to tutoring groups were taught by undergraduate education majors enrolled in a private college. Mastery learning and control groups were taught by classroom teachers.

The students participating in the studies attended a parochial school located in a middle-income neighborhood on the Southwest side of Chicago. The total population of the school's fourth, fifth, and eighth grades were involved in the studies.

Before each study began, a list of students was obtained and the students were randomly assigned to one of the three quality of instruction conditions, in order to secure comparability. The extent to which random assignment resulted in comparable groups was determined by examining the means and standard deviations for aptitude and prior achievement between the groups in each study. In all but one instance, random assignment resulted in comparable groups in terms of aptitude and prior achievement. The one exception involves the fifth grade tutoring group, where the mean level of aptitude was significantly higher than the mean for the conventional group. However, the mean levels of prior achievement for the fifth grade tutoring and conventional groups were similar.

Each study was conducted during a three-week period and incorporated three sequential learning tasks. During the first two weeks of each study, students received a total of four periods of instruction (each lasting 40 minutes) on each learning task before the formative tests were administered. Students in tutoring and mastery groups, who did not initially meet the criterion set for their respective groups, were given feedback/correctives.

In the third week of each study, students received three periods of instruction on the final task before the formative test was administered. Again, students in mastery and tutoring received correctives as needed to meet the criterion set for their group. Summative achievement tests were administered to all groups on the following day, the final day of each study.

Questionnaires were administered once each week on the day preceding the administration of a formative test. Items for the questionnaires were taken from instruments for measuring the students' perceptions of achievement, overt and covert time-on-task, and affect (i.e., attitude and interest). Observations of time-on-task for students in each condition were made three times each week during the first two weeks and twice during the final week of each study.

Results of the Studies

The results pertaining to each hypothesis are summarized here. The variables introduced in the model are defined and the methods used in measuring each variable are also discussed briefly.

Effects of quality of instruction on achievement

In discussing the model underlying these studies, a causal relationship was posited between the quality of instruction students receive and the achievement they attain. Instruction is viewed as a qualitative continuum, ranging from minimal to maximal. When students learn under a minimal condition, the instruction they receive is not responsive to individual learning needs and does not attempt to assure that the majority of students attain high levels of learning. Under a minimal condition, the students who do possess high levels of cognitive and affective

entry characteristics are able to attain high levels of learning, but the majority, who possess fewer of these characteristics, attain lower levels of learning. When students learn under a maximal condition, cues are adapted so they can be understood and used by the individual, reinforcements are provided which maintain or increase the individual's desire for further learning, and the amount and kind of practice needed by the individual to succeed in learning is provided. A maximal condition also incorporates a means of providing feedback about the level of learning which has been attained by the individual and of providing corrective instruction as weaknesses or errors in learning are identified. Under a maximal quality of instruction, the achievement students initially attain should be high, and their achievement should remain high or increase as they progress through a series of related learning tasks.

Hypothesis 1: Level and variation in student achievement is a function of the quality of the instruction given the students.

Quality of instruction is the extent to which cues, reinforcement, participation, and feedback/correctives are present and appropriate to the needs of individuals (Bloom, 1976) and the extent to which students are held to a high criterion level for achievement on formative tests. Three different quality of instruction conditions were used in the studies: (a) tutoring, a maximal quality which adapts each of the qualities of instruction to the individual student, (b) conventional group-based instruction, a minimal quality which is least adaptive to individual student needs, and (c) mastery learning, a quality which lies between the two extremes exemplified by tutoring and conventional instruction. Students who received tutoring were required to maintain a 90% criterion for learning

on formative tests and students under mastery learning were required to maintain a criterion of 80%.

In the hypothesis statement, achievement refers to the level of learning exhibited by students on formative and summative tests based on the content and objectives of a learning unit. Level is operationalized as mean achievement and variation, as standard deviation. Quality of group instruction was monitored to determine the availability of each component and the extent to which each component was adapted to the needs of individuals. In addition, the tutorials were observed, and the extent to which each tutor maintained a maximal quality of instruction was monitored.

In each of the three studies, the highest levels and smallest variations in summative achievement are found for the students who received tutoring, the maximal quality of instruction condition. The differences between the mean levels of achievement for tutoring and conventional groups are statistically significant. In the fifth grade study, less variation was also found within the mastery group than within the conventional group. An average of nearly 70% of the students in mastery conditions met or exceeded the levels of achievement attained by only 20% of the highest scoring students in conventional conditions.

Quality of instruction, when entered first in a stepwise regression, accounts for 36% of the variance in summative achievement in the fourth grade study, 48% of the variance in fifth grade, and 41% in the eighth grade. These results indicate that the achievement students attain is strongly affected by the quality of instruction they receive.

In all studies, differences appeared between the levels of achievement for tutoring and conventional groups as early as the first formative

test, and students under tutoring continued to maintain the highest levels of achievement on each succeeding formative test. Once students in mastery conditions were provided with feedback/correctives on the first learning task, they consistently maintained higher levels of achievement than were found for students under conventional conditions.

The data from all three studies support the hypothesis that level and variation in achievement is a function of the quality of instruction students are given. The achievement distributions we are accustomed to finding in schools are a phenomenon of the quality of instruction we traditionally provide--a quality which enables a few students to learn well, but inhibits the learning of many students. The levels of achievement reached by tutoring and mastery groups indicate that when instruction is responsive to the learning needs of individuals almost all students are able to attain the high levels of learning which are attained by only a small percentage of students under conventional conditions.

The data also strongly support the importance of a feedback/corrective component in maintaining a high quality of instruction condition and assuring that students attain the prior knowledge and skills required for succeeding with new learning. The disparity between the quality of instruction available under tutoring and conventional conditions during the initial teaching of a learning task would account for differences in the levels of achievement attained by students in the two learning conditions. However, the disparity in initial instruction is not in itself sufficient to explain the dramatic differences which appear after the first formative test, when students in tutoring begin receiving systematic feedback/corrective procedures. In addition, the only difference between the mastery and conventional conditions is in the provision of

feedback/correctives to the mastery groups. However, this single enhancement of the quality of instruction given students was sufficient to enable students learning under mastery conditions to acquire higher levels of achievement with less variation than students under conventional conditions.

Effects of quality of instruction on relations between students' cognitive characteristics and achievement

In addition to examining the effects of quality of instruction on achievement, the studies were also designed to examine the relations which develop between students' characteristics (prior achievement and aptitude) and their subsequent achievement under each quality of instruction condition. Strong relations between aptitude and achievement and between prior and subsequent achievement are usually found when students receive conventional group-based instruction. These strong relationships between characteristics of students and the achievement they attain have often served as the basis for generalizations about human potential for learning. However, the accumulating evidence from mastery learning studies strongly indicates that the influence of aptitude and prior achievement on subsequent achievement can be diminished by enhancing the quality of instruction the students receive. Theoretically, a quality of instruction which approximates a maximal learning condition should enable students to attain equally high levels of learning, despite initial variations in aptitude or prior achievement. Under a maximal condition, the relations between aptitude and achievement and between prior and subsequent achievement should be very weak.

Hypothesis 2: The relation between student achievement and prior measures of achievement and aptitude is determined by the quality of the instruction given the student.

Aptitude refers to an individual's ability to deal with general and abstract concepts, including the ability to interpret and use verbal and quantitative symbols and identify relationships among them. The Cognitive Abilities Test, Multilevel, Form 3 (Thorndike & Hagen, 1978) was used as the measure of aptitude. In the fourth and fifth grade studies, where mathematics (probability) was taught, scores on the quantitative battery were used. In the eighth grade study, where social studies (cartography) was taught, scores on the verbal battery were used. Teacher grades for either mathematics or social studies were the measure of prior achievement, depending on the content taught during a study.

The patterns of relations between prior achievement and summative achievement and between aptitude and summative achievement for students learning under different conditions are consistent in the three studies. The weakest relations are found when students receive tutoring and the strongest when students learn under conventional conditions.

In the tutoring and mastery groups, where instruction was adapted to the learning needs of individuals, prior achievement and aptitude account for only a small portion of the variation found in summative achievement. However, prior achievement and aptitude exerted a strong influence on the achievement attained by students learning under conventional conditions.

When students received tutoring, the initial teaching of the learning tasks was modified so that the individuals could comprehend and succeed with each element of a task before new learning was introduced.

The constant adjustment in instruction, which is possible when an individual is the focus of the instruction, diminished the effects of prior achievement on their subsequent achievement. In the studies, prior achievement accounts for an average of only about 1% of the variation in summative achievement for students in tutoring conditions.

The variation in summative achievement which can be accounted for by prior achievement under mastery conditions is also very small, an average of about 6%. However, in conventional groups, where instruction was not adapted to individual learning needs, prior achievement accounts for an average of about 25% of the variation in summative achievement.

The content of the learning units taught in all three studies placed heavy demands on the students' general reasoning abilities and abilities to deal with abstract concepts. Despite the complex nature of the units, students in tutoring conditions received the kinds of demonstrations and concrete examples which enabled individuals to grasp most of the more abstract elements of each task during the initial instruction. Under tutoring conditions, an average of about 10% of the variation in summative achievement can be explained by aptitude.

In conventional and mastery groups, the tasks were presented at a level of difficulty which was not adjusted to individual needs during the initial instruction. However, students in mastery conditions received individualized assistance with specific elements of each task during the feedback/corrective sessions. This enhancement of the quality of instruction available to mastery groups reduced the effects of aptitude on summative achievement. Aptitude accounts for an average of only about 15% of the variation in summative achievement when students learned under mastery conditions. It accounts for an average of about 38% of the

variation in achievement for students receiving conventional instruction.

The effects of quality of instruction on the relations which developed between aptitude and achievement were evident over the series of learning tasks. After the first learning task, the relations between aptitude and achievement are consistently weaker in tutoring and mastery groups than in conventional groups. In general, the relations between prior achievement and achievement over the series of learning tasks were weaker for tutoring and mastery groups than for conventional groups.

With the exception of the fifth grade tutoring group, where the mean level of aptitude was higher than for the other groups, students in the three learning conditions of each study were initially similar in aptitude and prior achievement. However, the relations which evolve between these prior characteristics and the summative achievement students attained are very different under tutoring, mastery, and conventional conditions. The results of the studies strongly indicate that the quality of instruction students receive determines the extent to which prior characteristics will influence the learning outcome students are able to attain.

Effects of quality of instruction on engagement in learning

In discussing the model, it was proposed that the extent to which students actively engage in learning is influenced by the quality of instructions they receive. The literature provides ample evidence that large differences are found in the extent to which students actively engage in learning under conventional conditions. This is understandable because few students under conventional conditions approach tasks well

prepared to attain high levels of learning, while the majority find they are increasingly unable to comprehend the instruction or attain a high degree of success in learning. It is unlikely that students who lack the prerequisites for new instruction will continue directing their energies and attention to active engagement in a task which is progressively incomprehensible to them. Both the desire and the ability to be active participants would be expected to decrease.

Evidence that quality of instruction is capable of affecting students' involvement in learning is provided by studies comparing time-on-task under mastery learning and conventional conditions. The quality of instruction available to mastery students is enhanced by the provision of feedback/corrective strategies which enable almost all students to enter subsequent tasks with the prerequisite learnings needed for active participation in the lessons. Higher levels of task involvement and smaller variations are generally found for students in mastery conditions than for students in conventional conditions. The highest levels of engagement in learning should occur when students receive initial instruction which is adapted to their learning needs, in addition to the feedback/corrective strategies.

Hypothesis 3: Level and variation in the percentage of time students are actively engaged in learning is a function of the quality of instruction students are given.

In the hypothesis statement, actively engaged in learning refers to time-on-task. Time-on-task is the percentage of time students are observed to be on-task. Observations of time-on-task were made using a scale developed by Good and Beckerman (1978). In addition, student reports of

overt and covert time-on-task were obtained for each learning task from their responses to pertinent items on an instrument for measuring perceived time-on-task. For example, students were asked to indicate if they had listened carefully to questions posed by the teacher, thought about something other than the subject being taught, completed their assigned work, and responded to a question raised during the instruction. Items for the instrument were adapted from scales developed for the National Longitudinal Study of Mathematics Achievement and from scales developed by Hecht (1977).

At the completion of the final learning task of each of the three studies, students in tutoring conditions reported significantly higher levels of overt and covert time-on-task than were reported by students in conventional instruction conditions. Students who received tutoring were on-task an average of about 89% of the time during the final task, but students receiving conventional instruction were on-task an average of only about 66%. The higher levels of task involvement in tutoring are accompanied by smaller variations than are found in conventional conditions.

Differences in the mean levels of reported overt and covert time-on-task were also found between the mastery and conventional groups during the final learning task. Students under mastery were on-task an average of about 74% of the time. Variation in time-on-task under mastery conditions was also smaller than under conventional conditions in each of the studies.

The mean levels of observed time-on-task found for students under all learning conditions were unusually high, particularly in the fourth and fifth grade studies. During the final learning task of each of the three studies, students under tutoring were observed to be on-task about 100% of

the time, under mastery an average of 91%, and under conventional conditions an average of 79%. Although observed time-on-task is unusually high, the patterns of mean levels of observed task behaviors under the different learning conditions duplicate the patterns of overt and covert time-on-task which were reported by the students. However, the more moderate levels of task behaviors reported by students are believed to offer a more realistic view of the students' engagement in learning, and it is these reports which serve as the basis for discussing how students' task behaviors changed within the three different instructional conditions during the studies.

High levels of time-on-task and small variations were expected for students in tutoring and mastery conditions. Students who were given tutoring had immediate access to a teacher whenever they had a question or needed additional assistance. They were able to obtain the help they needed to maintain active involvement in learning during the instructional sessions. In addition, these students also received feedback/correctives which assured that they entered each successive task with the cognitive behaviors essential to comprehending and participating in the lessons.

The differences in involvement between mastery and conventional groups can be explained by the availability of feedback/correctives to mastery students. At the completion of each learning task, the learning problems of mastery students were identified, and students received individual assistance in correcting mistakes in their original learning. As a result of this process, mastery students entered new tasks with the prerequisites for active and productive involvement in learning.

The feedback/correctives also enabled students in tutoring and mastery conditions to obtain evidence that they were capable of learning

well. This evidence was obtained from their achievement on an alternative version of the initial formative test administered for a learning task. As high levels of learning were reached on each task, the students were expected to develop a more positive concept of ability to learn and stronger motivation for active engagement in further learning.

In contrast with the quality of instruction available to tutoring and mastery groups, instruction was not adapted to individual learning needs for students under conventional conditions. The majority of the students receiving conventional instruction had not acquired the prerequisites they needed to comprehend the final task, and this is reflected in the lower levels of time-on-task and larger variations found for these students.

The effects of quality of instruction on students' engagement in learning are significant and immediate in these studies. The highest levels of time-on-task for each learning task of the series were consistently found for the students who received tutoring. Although the levels of time-on-task for students under mastery and conventional conditions were similar on the first task taught in each of the three studies, once mastery students begin receiving feedback/correctives, they attain levels of time-on-task which indicate more effective use of learning time than is found in conventional conditions. In the tutoring and mastery groups, levels of task involvement either remain at high levels throughout the series of tasks or increase as students progress through the series. In conventional groups, levels of task involvement either remain low or decrease over the series of tasks.

Relations between students' achievement and perception of achievement and their affect toward learning

The final problem examined by the studies involves the development of subject-specific affect (i.e., attitude and interest) toward learning. The model posits achievement and students' perceptions of achievement as important influences on the affect students develop toward learning. The affect may in part develop from the objective evidence students receive about the level of success they have attained in learning. However, it is believed that affect also evolves from the extent to which students perceive of their learning as adequate. Bloom (1971) has proposed a causal relation between students' perceptions of the adequacy of their learning of a specific task and the affect they develop toward the task. He also argues that the perceptions are derived from comparisons students make between their own achievement and the achievement of others in their immediate learning environment. Theoretically, students who are successful with the content and skills of a learning task and who perceive themselves as successful should develop positive attitudes and interest toward the task. Attitudes and interest among students who achieve little success with the task and do not perceive their learning as adequate should be relatively low.

Mastery learning studies indicate that when students receive a quality of instruction enabling the majority of students to succeed in learning, they develop more positive attitudes and interest in learning than is found for the majority of students receiving conventional instruction. In the studies here, the highest levels of positive affect should occur for students who receive tutoring, which provides a quality of instruction approaching the maximal for individuals.

Hypothesis 4: Affect toward learning develops as a function of the achievement students attain and of their perception of the adequacy of their achievement.

Affect toward learning was operationalized as the attitude and interest students reported for the subjects taught during the learning units. It was measured for each learning task, using selected items from affective scales developed for the National Longitudinal Study of Mathematics Achievement (NLSMA) and from scales developed by Dolan (1974). Perception of achievement is the judgment made by students about the adequacy of the level of learning they attain. Selected items from the Brookover Self-Concept of Ability measure and from scales developed for the NLSMA studies were used in measuring this variable.

The initial measures of affect and of perception of achievement were administered before students had received objective evidence of their achievement. In the three studies, the relations between affect and achievement and between affect and perception of achievement are very weak during the first learning task. The median correlation for affect and achievement on the first task is -.02, and the median for affect and perception of achievement is .27. However, by the time students responded to the final measures of affect and perception of achievement, they had received information about their level of achievement from the results of formative tests administered at the completion of the first and second learning tasks. The median correlation between affect at the end of the series of learning tasks and summative achievement is .19, and the median for affect and perception of achievement is .55.

Support for hypothesizing that affect for learning evolves from achievement and perception of achievement is provided by the multiple

correlations for the fourth and eighth grade studies. In the fourth grade, achievement and perception of achievement account for only 14% of the variability in affect during the first task but for 31% of the variability during the final task. The changes which occur in the eighth grade study are even more striking. In the eighth grade, achievement and perception of achievement account for only 8% of the variability in affect on the first task but for 42% on the final task. There is little change in the relations between variables over the series of learning tasks in the fifth grade study.

In all three studies, the relations between perception of achievement and affect toward learning were stronger than the relations found between achievement and affect. An average of about 30% of the variation in students' affect at the end of the series of learning tasks can be accounted for by their perception of their achievement, alone. In comparison, summative achievement accounts for only about 8% of the variation in final affect. These results suggest that once the students' perceptions of their own achievement are known, knowledge of the achievement they actually attained makes little additional contribution to predicting the affect they will profess for learning.

In each of the studies, students reported high levels of perception of achievement during the first task, regardless of learning condition. However, on the final measure of perception of achievement, the highest levels of perception of achievement are found for students receiving tutoring and the next highest for students in mastery groups. Students learning under conventional conditions report comparatively low levels of perception of achievement. The patterns which emerge for perception of achievement under different learning conditions essentially

replicate the patterns reported earlier for achievement and time-on-task under different learning conditions.

In each of the three studies, the highest levels of positive affect toward learning occurred for students receiving tutoring. Under tutoring conditions, the levels of affect increased over the series of learning tasks while the variability decreased. Differences in the affect reported by students learning under tutoring and conventional conditions were statistically significant on the first and the final tasks of the series.

The results of the eighth grade study provide the strongest support for asserting that quality of instruction is capable of altering the affect students develop toward learning. In this study, students in both tutoring and mastery conditions reported more positive affect than did either the conventional group as a whole or the top achieving 20% of the conventional students.

The results of the studies indicate that the affect students develop toward learning emanates from their achievement and their perception of the adequacy of the achievement. The relation between affect and perception of achievement is particularly strong. The results for all tutoring groups and for the eighth grade mastery group also suggest that when the quality of instruction students receive alters their level of achievement, this in turn alters the affect they develop toward learning.

Limitations of the studies

Several limitations on the generalizability of the studies need to be reviewed before the larger implications are discussed. The students who participated in the studies do not represent a random sample of the population of students attending United States schools. All students in

the three studies attend a parochial school and live in a middle-income neighborhood. The two most common occupations held by the students' fathers are policeman and fireman. It is possible that the results of the studies would not have been the same had the students come from backgrounds at the extreme edges of the economy.

The studies were conducted for a brief period of time. Each lasted only three weeks. The results might have been different had the studies continued for a semester or a year. The results would certainly not have been as strong had the studies lasted for only one week. However, a question remains about whether the results found for the studies reported here would be sustained in studies conducted over a longer period of time.

The studies were also concerned with only three different grade levels and two different subject areas. Additional research will have to determine if the results hold for other grade levels and academic subjects.

Implications

Most of what is known or assumed about the capabilities of individuals for school learning is based on research which examines learning outcomes when students receive conventional group-based instruction. The patterns of cognitive and affective learning which emerge under conventional conditions have led to a number of untested assumptions about human potential for learning. One of the more widely accepted of these is that a few students are innately more capable of learning what the schools teach than are the majority of the school-age population. This assumption leads to another which has had a large impact on the way we view and respond to individual students, and that is, the assumption that the distribution of achievement presently found in schools is a natural and inevitable result

of differences in the prior cognitive and affective characteristics of individual learners.

The research findings reported here challenge both assumptions. The patterns of achievement which emerged under each of the three studies provide strong, consistent evidence that the learning outcomes students attain are a function of the quality of instruction they receive. Under tutoring conditions, where the instruction was most adaptive to individual needs, more than 90% of the students reached or exceeded the levels of achievement attained by only the highest-achieving 20% of the students under conventional conditions. In mastery learning conditions, where group-based instruction was enhanced through feedback/correctives, about 70% of the students reached or exceeded the levels of achievement found for the top 20% under conventional conditions. Inequalities in the learning outcomes students obtain are neither natural nor inevitable; they are, instead, the consequences of providing students with instruction which is not adapted to the learning needs of individuals. The conditions under which students learn can either enhance or inhibit their achievement, depending on the quality of the instruction.

A second major implication which can be drawn from the three studies is that the extent to which aptitude or prior achievement will influence the achievement students attain is determined largely by the quality of instruction given to the students. A great deal of educational thought and planning in the past has been based on the presumption of a scale of academic potentials among learners. This scale of potentials has been invoked over several decades of educational research as an explanation of what seemed to be the inevitability of an inequality of learning outcomes among students and as an explanation of the strong relations found between

student characteristics, such as aptitude and prior achievement, and the achievement they attained. The results of the studies reported here suggest that strong relations between individual characteristics and achievement are largely an unacknowledged by-product of the quality of instruction we traditionally provide in schools. Under tutoring and mastery learning the relations were weak, and very little of the variation in achievement over the learning units could be explained by differences in either prior achievement or aptitude. This is very different from the findings under conventional conditions, where the relations between each of the two prior characteristics and subsequent achievement continued to be strong. Additional research will be needed to determine if these results hold for other kinds of school learning. However, the findings of the three studies clearly indicate that previous assumptions about human potential for school learning must be reassessed.

The results of these studies support the theoretical position, argued by Bloom (1976; 1978), that the differences we observe in students' learning and school achievement are manmade and accidental. This position holds that when learning conditions are favorable for the individual what can be learned by other persons can also be learned by the individual. Bloom qualifies the applicability of the theory by noting that about 5% of the population may prove exceptions either because they learn in extremely capable ways or because they have extreme physical or emotional problems which limit learning. Theoretically 95% of the student population should attain the highest levels of learning when the instructional environment approximates a maximal condition. Under the tutoring conditions in each of the three studies, more than 90% of the students reached the highest levels of learning. These findings are very close to the theoretical limits proposed by Bloom's theory.

Because the three quality of instruction conditions employed in these studies consistently produced three distinctively different levels of achievement, the studies support the view that quality of instruction is a continuum ranging from minimal to maximal. The clear implication is that other enhancements of quality of instruction are likely to produce positive results. The findings of mastery learning studies are sufficiently compatible with each other to provide a fairly clear understanding of the limits to which learning can be increased when instruction is enhanced after the initial teaching has occurred. Research is now needed which focuses on identifying the particular aspects of tutoring that can be incorporated into the initial instruction students receive under group-based conditions. The results of the studies reported here can serve as a yardstick for measuring the effectiveness of future attempts to enhance the quality of instruction.

The effects of quality of instruction on cognitive and affective learning and on learning processes, such as engagement in learning, were immediate and measurable in a brief period of time. Under the maximal condition, the effects were evident on the first learning task. The findings indicate that it is no longer necessary to wait a semester or a year before determining whether or not a new procedure for enhancing instruction has been effective. According to the results of these studies, the trend should appear early, and the effects should be measurable week by week.

The quality of instruction the students received also influenced the way they perceived of themselves as learners. Students who learned under tutoring or mastery conditions developed more positive concepts of their own ability to learn and to meet high standards for achievement than did students under conventional conditions, although the groups were

comparable in terms of prior achievement or aptitude. When the quality of instruction enabled students to learn well, they became confident of their ability to succeed with the learning, and the data strongly suggests that this, in turn, resulted in more positive affect toward learning. Additional research is needed to establish the linkage between achievement and perception of achievement and the affect students develop toward learning, but these studies provide a clear direction for further research.

Another implication which emerges from this research is that students, regardless of their prior history as learners, will respond with high levels of task involvement when the instruction they receive enables them to gain the knowledge and skills needed to comprehend and succeed with the learning task. During the final task of each of the three studies, students within tutoring and mastery groups were more actively engaged in learning and more alike in their levels of task involvement than were students under conventional conditions. Student inattentiveness and off-task behaviors may well be signals that the quality of instruction they are receiving is not meeting the learning needs of individuals. Future research needs to be directed toward adapting the initial instruction students receive under group-based conditions so that students attain the prerequisites for becoming active participants in learning at the onset of instruction.

This research has focused on the effects of quality of instruction, a variable within the control of schools and educators. Quality of instruction has been shown to be an alterable variable, which exerts a pervasive influence on learning outcomes and learning processes. Differences in the learning and achievement students attain can no longer be justified

as an inevitability of differences in their cognitive and affective characteristics. The concept of students as possessing greater or lesser degrees of academic potential becomes meaningless, in view of the findings reported here. However, in order for students to begin realizing their full potential as learners, the means must be found for adapting instruction to the needs of individuals early in group-based learning conditions.

REFERENCES

Agris, M. S. A study to determine the effects of a student programmed tutoring project in first grade reading. Unpublished doctoral dissertation, University of Pennsylvania, 1979

Aiken, L. R. Attitudes toward mathematics. Review of Educational Research, 1970, 40, 551-596.

Aiken, L. R. Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46, 293-311.

Allen, V., & Devin-Sheehan, L. The tutor as role model: Effects of imitation and liking on student tutors (technical report no. 304). Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, 1974.

Allen, V., & Feldman, R. Effects of tutee performance on tutor's verbal and nonverbal behavior (technical report no. 305). Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, 1974.

Anderson, L. Time and school learning. Unpublished doctoral dissertation, University of Chicago, 1973.

Anderson, L., & Scott, C. The relationship among teaching methods, student characteristics, and student involvement in learning. Journal of Teacher Education, 1978, 19 (3), 52-57.

Anderzhon, M. Steps in map reading. Chicago: Rand McNally & Co., 1970.

Arlin, M. Learning rate and learning rate variance under mastery learning conditions. Unpublished doctoral dissertation, University of Chicago, 1973.

Bausell, R., Moody, W., & Walzl, F. A factorial study of tutoring versus classroom instruction. American Educational Research Journal, 1972, 9, 592-597.

Bennett, S. N. Recent research on teaching: A dream, a belief, and a model. The British Journal of Educational Psychology, 1978, 48 (2), 127-147.

Bernstein, C. E. The effects of group versus individual tutoring on the achievement of word recognition skills. Unpublished doctoral dissertation, University of Miami, 1979.

Block, J. The effects of various levels of performance on selected cognitive, affective, and time variables. Unpublished doctoral dissertation, University of Chicago, 1970.

Block, J., & Burns, R. Mastery learning. In L. Shulman (Ed.) Review of research in education (Vol. 4). Itasca, Ill.: F. E. Peacock Pub., 1977.

Bloom, B. S. Affective consequences of school achievement. In J. Block (Ed.), Mastery learning: Theory and practice. New York: Holt, Rinehart & Winston, Inc., 1971.

Bloom, B. S. Time and learning. American Psychologist, 1974, 29 (9), 682-688.

Bloom, B. S. Human characteristics and school learning. New York: McGraw-Hill Book Co., 1976.

Bloom, B. S. Affective outcomes of school learning. Phi Delta Kappan, 1977, 59 (3), 193-198.

Bloom, B. S. New views of the learner: Implications for instruction and curriculum. Educational Leadership, 1978, 35, 563-576.

Bloom, B. S. The new direction in educational research: Alterable variables. In The state of research on selected alterable variables in education (Mesa Seminar). Chicago: Department of Education, University of Chicago, 1980.

Bloom, S. Peer and cross-age tutoring in the schools. Washington, D. C.: National Institute of Education, 1976.

Brookover, W., Erickson, E., & Joiner, L. Self concept of ability and school achievement, III: Relationship of self-concept to achievement in high school (Educational Research Series No. 36). East Lansing, Michigan: Educational Publication Services, 1967.

Brophy, J., & Good, T. Teachers' communications of differential expectations for children's classroom performance: Some behavioral data. Journal of Educational Psychology, 1970, 61, 365-374.

Brophy, J., & Good, T. Teacher-student relationships: Causes and consequences. New York: Holt, Rinehart & Winston, Inc., 1974.

Broudy, H. S. Historical exemplars of teaching methods. In N. L. Gage (Ed.), Handbook of research on teaching. Chicago: Rand McNally and Co., 1963.

Calsyn, R., & Kenny, D. Self-concept of ability and perceived evaluation of others: Cause or effect of academic achievement? Journal of Educational Psychology, 1977, 69 (2), 136-145.

Campbell, D., & Stanley, J. Experimental and quasi-experimental designs for research. Chicago: Rand McNally College Pub. Co., 1963.

Carroll, J. A model of school learning. Teachers College Record, 1963, 64, 723-733.

Cloward, R. Studies in tutoring. Journal of Experimental Education, 1967, 36, 14-25.

deLone, R. Small futures: Children, inequality, and the limits of liberal reform. New York: Harcourt Brace Jovanovich, 1979.

Devin-Sheehan, L, Feldman, R., & Allen, V. Research on children tutoring children: A critical review. Review of Educational Research, 1976, 46 (3), 355-385.

Dolan, L. Affect and school achievement: Some theoretical and empirical issues. Unpublished manuscript, University of Chicago, 1974.

Dollard, J., & Miller, N. Personality and psychotherapy. New York: McGraw-Hill Book Co., Inc., 1950.

Dunkin, M., & Biddle, B. The study of teaching. New York: Holt, Rinehart & Winston, Inc., 1974.

Ellson, D. Tutoring. In N. L. Gage (Ed.), The psychology of teaching methods, part 1. The seventy-fifth yearbook of the National Society for the Study of Education. Chicago, Ill.: The University of Chicago Press, 1976.

Ellson, D., Harris, P., & Barber, L. A field test of programed and directed tutoring. Reading Research Quarterly, 1968, 3, 307-367.

Froemel, J. Cognitive entry behaviors, instructional conditions and achievement: A study of their interrelationships. Unpublished doctoral dissertation, University of Chicago, 1980.

Gable, R., Roberts, A., & Owen, S. Affective and cognitive correlates of classroom achievement. Educational and Psychological Measurement, 1977, 37 (4), 977-986.

Getzels, J. W. A social psychology of education. In G. Lindzey & E. Aronson (Eds.), The handbook of social psychology, Vol. 5: Applied social psychology. Reading, Mass.: Addison-Wesley Pub. Co., 1969.

Gilkey, A. D. The predictive strength of an interest measurement in student performance. Unpublished doctoral dissertation, Temple University, 1978.

Glass, G. V. Does class size make a difference? Instructor, 1979, 89 (4), 22.

Glass, G. V., & Smith, M. L. Meta-analysis of research on the relationship of class-size and achievement. Educational Evaluation and Policy Analysis, 1979, 1 (1), 2-16.

Good, T., & Beckerman, T. Time on task: A naturalistic study in sixth-grade classrooms. Elementary School Journal, 1978, 78 (3), 193-207.

Greenhood, D. Mapping. Chicago: The University of Chicago Press, 1964.

Harnischfeger, A., & Wiley, D. Teaching-learning processes in elementary school: A synoptic view (MehrLicht! Studies of Educative Processes, Report No. 9). Chicago: D. Wiley, Department of Education, University of Chicago, 1975.

Harris, R. The Rand McNally handbook of map and globe usage (4th ed.). Chicago: Rand McNally & Co., 1967.

Hecht, L. Isolation from learning supports and the processing of group instruction. Unpublished doctoral dissertation, University of Chicago, 1977.

Hilgard, E., & Bower, G. Theories of learning (3rd ed.). New York: Appleton-Century-Crofts, 1966.

Hoge, R., & Luce, S. Predicting academic achievement from classroom behavior. Review of Educational Research, 1979, 49 (3), 497-511.

Husen, T. (Ed.). International study of achievement in mathematics: A comparison of twelve countries (Vols. I and II). New York: John Wiley & Sons, 1967.

Jackson, P. W. Life in classrooms. New York: Holt, Rinehart & Winston, 1968.

Kifer, E. The effects of school achievement on the affective traits of the learner. Unpublished doctoral dissertation, University of Chicago, 1973.

Klosterman, R. The effectiveness of a diagnostically structured reading program. The Reading Teacher, 1970, 24 (2), 159-167.

Kulhavy, R. Feedback in written instruction. Review of Educational Research, 1977, 47 (2), 233-244.

Lehrer, B., & Hieronymus, A. Predicting achievement using intellectual, academic-motivational and selected non-intellectual factors. Journal of Experimental Education, 1977, 45 (4), 44-51.

Lindsey, J. K. A re-analysis of class size and achievement as interacting with four other critical variables in the IEA mathematics study. Comparative Education Review, 1974, 18 (2), 314-326.

Malpass, L. Some relationships between students' perceptions of school and their achievement. The Journal of Educational Psychology, 1953, 44, 475-482.

McKeachie, W. The decline and fall of the laws of learning. Educational Researcher, 1974, 3, 7-11.

Neale, D. The role of attitudes in learning mathematics. Arithmetic Teacher, 1969, 16, 631-640.

Neale, D., Gill, N., & Tismer, W. Relationship between attitudes toward school subjects and school achievement. The Journal of Educational Research, 1970, 63 (5), 232-237.

Nordin, A. B. The effects of different qualities of instruction on selected cognitive, affective and time variables. Unpublished doctoral dissertation, University of Chicago, 1979.

O'Brien, M., & Ginsburg, K. Time-on-task and student achievement. In The state of research on selected alterable variables in education (Mesa Seminar). Chicago: Department of Education, University of Chicago, 1980.

Olson, W. C. A study of classroom behavior. Journal of Educational Psychology, 1931, 22, 449-454.

Scheirer, M., & Kraut, R. Increasing educational achievement via self concept change. Review of Educational Research, 1979, 49 (1), 131-150.

School Mathematics Study Group. Probability for Intermediate Grades. Palo Alto, Calif.: Stanford University Press, 1966.

Scudder, B. E. A comparative study of the effects of the use of a diagnostic/prescriptive approach versus a tutorial approach to the teaching of English to non-English speaking elementary school children in a large urban school district in Colorado. Unpublished doctoral dissertation, University of Colorado at Boulder, 1979.

Shapson, S., Wright, E., Eason, G., & Fitzgerald, J. An experimental study of the effects of class size. American Educational Research Journal, 1980, 17 (2), 141-152.

Shepler, J. L. A study of parts of the development of a unit in probability and statistics for the elementary school: Report from the project on analysis of mathematics instruction (Technical Report no. 105). Madison, Wisconsin: Wisconsin Research and Development Center for Cognitive Learning, University of Wisconsin, 1969.

Shulte, A., & Choate, S. What are my chances? (book A). Palo Alto, Calif.: Creative Publications, 1977.

Simpson, S. Comment on "meta-analysis of research on class size and achievement". Educational Evaluation and Policy Analysis, 1980, 2 (3), 81-83.

Solomon, D., Rosenberg, L., & Bezdek, W. Teacher behavior and student learning. Journal of Educational Psychology, 1964, 55, 23-30.

Thorndike, R., & Hagen, E. Measurement and evaluation in psychology and education. New York: Wiley, 1961.

Thorndike, R., & Hagen, E. Technical manual: Cognitive abilities test, multi-level edition. New York: Houghton Mifflin Co., 1974.

Thorndike, R., & Hagen, E. Cognitive abilities test, multi-level, form 3. New York: Houghton Mifflin Co., 1978.

Torshen, K. The relation of classroom evaluation to students' self-concepts and mental health. Unpublished doctoral dissertation, University of Chicago, 1969.

Uguroglu, M., & Walberg, H. Motivation and achievement: A quantitative synthesis. American Educational Research Journal, 1979, 16 (4), 375-389.

Walberg, H., & Rasher, S. Public school effectiveness and equality: New evidence and its implications. Phi Delta Kappan, 1974, 56, 3-9.

Walker, D. The IEA six subject survey: An empirical study of education in twenty-one countries. New York: Halsted Press, 1976

Wolf, R. Achievement in America: National report of the United States for the International Educational Achievement project. New York: Teachers College Press, 1977.

APPENDIX A

SUPPLEMENTARY TABLES

TABLE 9

RELIABILITY OF FORMATIVE AND SUMMATIVE TESTS

Group	FT 1A	FT 2A	FT 3A	Summative
Fourth Grade	.6149	.7586	.1153	.7184
Fifth Grade	.6836	.6474	.1514	.6595
Eighth Grade	.6673	.5420	.5452	.7230

Kuder-Richardson formula number 21 was used to determine test reliability. Means and standard deviations for the conventional instruction groups in each grade level were used in the calculations.

Table 10

COMPARISON OF OBSERVED TIME-ON-TASK

Group		Learning Task 1	Learning Task 2	Learning Task 3
Fourth Grade				
Tutoring	$\bar{x}$	91.50	95.75	100.00
(n = 20)	s	8.25	8.35	.00
Mastery	x	95.60	92.25	92.60
(n = 26)	s	6.05	10.05	10.25
Conventional	x	95.00	86.35	86.75
(n = 24)	s	4.85	20.75	14.45
Fifth Grade				
Tutoring	x	97.65	98.15	99.50
(n = 20)	s	7.00	3.85	2.25
Mastery	x	94.75	90.45	94.25
(n = 26)	s	10.85	9.60	9.10
Conventional	x	90.55	84.55	82.80
(n = 28)	s	8.50	12.70	15.85
Eighth Grade				
Tutoring	x	100.00	100.00	100.00
(n = 21)	s	.00	.00	.00
Mastery	x	75.95	87.95	86.10
(n = 27)	s	26.40	18.80	20.00
Conventional	x	77.25	62.10	67.40
(n = 33)	s	31.50	33.15	32.15

TABLE 11

RELATIONS BETWEEN STUDENT REPORTS OF OVERT AND COVERT TOT, ACHIEVEMENT, AND QUALITY OF INSTRUCTION

Grade Level Groups	Relations During the First Task				Relations at End of Series of Tasks			
	Achievement and TOT	Achievement and Quality of Instruction	Quality of Instruction and TOT	Multiple R TOT:: Quality of Instruction and Achievement	Summative Achievement and TOT	Summative Achievement and Quality of Instruction	Quality of Instruction and TOT	Multiple R TOT:: Quality of Instruction and Summative Achievement
Fourth (n = 70)	-.04	.18	.47	.47	.35	.60	.46	.47
Fifth (n = 74)	.20	.43	.16	.22	.22	.69	.28	.29
Eighth (n = 82)	.15	.53	.47	.47	.26	.64	.46	.46
Median	.15	.43	.47	.47	.26	.64	.46	.46

Correlations for the first task are based on measures administered at the end of the first task. Correlations for the end of the series are based on measures of overt and covert TOT during the final task and summative achievement.

TABLE 12

SUMMARY OF STUDENTS' PERCEPTIONS OF THE APPROPRIATENESS OF CUES AND REINFORCEMENT UNDER DIFFERENT QUALITY OF INSTRUCTION CONDITIONS

Group		Cues			Reinforcement		
		Wk. 1	Wk. 2	Wk. 3	Wk. 1	Wk. 2	Wk. 3
Fourth Grade							
Tutoring	$\bar{x}$	1.80	1.53	1.73	1.38	1.30	1.33
(n = 20)	s	.34	.40	.28	.53	.57	.42
Mastery	$\bar{x}$	1.65	1.59	1.46	1.27	1.25	1.26
(n = 26)	s	.44	.43	.52	.60	.51	.58
Conventional	$\bar{x}$	1.44	1.28	1.22	1.19	1.04	1.24
(n = 24)	s	.61	.54	.54	.44	.57	.33
Fifth Grade							
Tutoring	$\bar{x}$	1.68	1.60	1.68	1.73	1.35	1.37
(n = 20)	s	.41	.44	.51	.34	.49	.47
Mastery	$\bar{x}$	1.52	1.37	1.55	1.29	1.13	1.14
(n = 26)	s	.56	.47	.40	.55	.67	.55
Conventional	$\bar{x}$	1.59	1.49	1.38	1.39	1.20	1.24
(n = 28)	s	.45	.52	.60	.39	.57	.57
Eighth Grade							
Tutoring	$\bar{x}$	1.95	1.76	1.86	1.83	1.26	1.63
(n = 21)	s	.22	.41	.34	.29	.49	.36
Mastery	$\bar{x}$	1.63	1.29	1.68	1.18	.86	1.42
(n = 28)	s	.52	.62	.56	.55	.58	.49
Conventional	$\bar{x}$	1.39	.89	1.31	1.21	.70	1.01
(n = 33)	s	.57	.59	.61	.59	.61	.54

The maximum possible score is 2.

APPENDIX B

INSTRUMENTS

Student Perception of Overt and Covert Time-on-Task Instrument

The word cartography was substituted for probability on the eighth grade questionnaires. Students responded by circling yes, don't know, or no to each item.

Covert Time-on-Task

1. I started to work very quickly in class today.
2. I thought about something besides probability in class today.
3. I listened very carefully when my teacher explained the work for today.
4. I like to think about answers to probability problems.
5. Sometimes my teacher thinks I am working on probability when I am really thinking about something else.
6. Some of the work today was so boring that I thought about something else for a while.
7. I paid attention almost the whole class today.
8. I listened carefully to the probability questions that my teacher asked today.

Overt Time-on-Task

1. The teacher didn't call on me at all today.
2. I hate it when my teacher asks me a question about probability.
3. I didn't really do all of the probability experiments today.
4. I asked my teacher for help when I needed it.
5. I always finish my probability work.
6. My teacher had to remind me to pay attention in class today.
7. I told my teacher the answer to a probability question today.

Perception of Achievement Instrument

Items from this instrument were included on the questionnaires which were administered at three points during each of the three studies. The word cartography was substituted for probability on the questionnaires for the eighth grade study. Students were given the choice of responding yes, don't know, or no to items 1-11. Choices for items 12 and 13 are stated here.

Items

1. I like to be called on in probability class.
2. I try to do the very best work in probability that I can.
3. My probability teacher thinks my work is very good.
4. I am very proud of my probability work.
5. Probability is easier for me than some of my other subjects.
6. I feel upset in probability class.
7. I am discouraged with my probability work.
8. I find it hard to talk in front of my probability class.
9. Most of the students in my class know more about probability than I do.
10. My probability teacher makes me feel I am doing poorly.
11. I think I am not doing very well in probability class.
12. What kind of grades do you think you are capable of getting in probability?

    the best grades average grades the poorest grades

13. Forget for a minute how others grade your work. How good do you think your work is in probability class?

    My work is excellent.
    My work is average.
    My work is poor.

Affect Toward Learning Instrument

In these studies affect refers to attitude and interest toward learning the content of the studies. In the eighth grade study, the word cartography was substituted for probability on the questionnaires. Students responded yes, don't know, or no.

Attitude

1. Probability is more difficult to understand than any other subject.
2. I think everybody should learn probability.
3. I cannot understand why some students think probability is fun.
4. Probability is not really useful because it is just about ideas.
5. Probability is more like a game than it is like school work.
6. Probability is boring.
7. I do not think it is important to understand probability.

Interest

1. Probability is one of my favorite subjects.
2. I would like to do more work with probability.
3. I would like to show somebody else how to do probability.
4. I think doing probability work is a waste of time.
5. I enjoy learning about probability.
6. I would like to invite a probability expert to speak to my class.
7. I want to learn more about probability.

Instrument for Monitoring Student Perception of Quality of Instruction (Cues and Reinforcement)

In addition to monitoring levels of student participation and the availability of the feedback/corrective component, the quality of instruction available under each of the different learning conditions was monitoring at three points by obtaining students' perceptions of the cues and reinforcements available under each condition. Students responded yes, don't know, or no to each item. Cartography was substituted for the eighth grade.

Cues

1. My probability teacher explains things so that I know what I am expected to do.
2. I understand the questions my probability teachers asks me.
3. If I don't understand something about probability then my teacher explains it to me again.
4. My teacher shows me different ways to do my probability work.
5. I don't understand when my teacher explains probability.
6. I usually don't understand why I am supposed to do a probability experiment.
7. Sometimes I don't know what I am supposed to do with the things my teacher gives me in probability class.
8. If I don't understand a probability question then my teacher explains it to me again.

Reinforcement

1. I like to tell answers to probability questions even when I am not certain my answer is right.
2. I would finish my probability work even if my teacher didn't care if I finished it or not.

4. My teacher always tells me when my work is good.

5. My friends think I know a lot about probability.

6. The answers I thought of in probability class were usually wrong.

7. My probability teacher doesn't always tell me if my answer is right or wrong.

8. If I think a probability question is too hard then I stop working on it.

Coding Sheet for Monitoring the Quality of Instruction Provided in Tutorials

Tutor#_____

	Yes	Sometimes	No
1. Arrives on time for the tutorial.			
2. Has organized materials for instruction.			
3. Provides a clear explanation of each task.			
4. Provides additional and altered cues when needed.			
5. Varies instructional materials when needed.			
6. Reinforces correct responses and appropriate behaviors.			
7. Uses a variety of verbal and nonverbal behaviors to encourage participation.			

Objectives for a Three Week Unit on Cartography for Students in Eighth Grade

At the completion of the learning tasks for the cartography unit, students should have acquired the following knowledge and skills:

1. Recognizes maps as representing a collection of highly selected information, organized and symbolized for the reader by a cartographer.

2. Accurately locates and records the exact positions of points on the earth's surface by noting distance north or south of the equator (latitude) and east or west of the Prime Meridian (longitude).

3. Uses latitude to determine where the sun is at zenith, and uses longitude to determine the time at any point on the earth.

4. Compares a variety of flat maps with a globe and describes the distortions which occur when a spherical surface is represented on a flat surface.

5. Compares a variety of map projections and describes their advantages and disadvantages with regard to size, shape, distance, and direction.

6. Uses standardized map symbols in interpreting and constructing topographic maps.

7. Uses and constructs map scales to determine distance between points on the earth.

8. Reorganizes written data and represents them on maps with appropriate symbols, using correct direction and distance.

Materials used in preparing the cartography unit are discussed on pages 60 and 61. The suggested scope and sequence chart prepared by the CBS Learning Center (Princeton, New Jersey) was especially helpful in identifying appropriate objectives for the cartography unit.

Objectives for a Three Week Unit on Probability for Students in Fourth and Fifth Grades

At the completion of the learning tasks for the probability unit, students should have developed skill in the following:

1. Distinguishes between certain, possible, and impossible events.
2. Identifies the set of possible outcomes of an experiment.
3. Identifies equally likely outcomes of an experiment.
4. Identifies unequally likely outcomes of an experiment.
5. Writes and interprets statements of probability in symbolic form.
6. Collects data about the frequency of events and interprets the results.
7. Applies basic rules of probability.
8. Determines experimental probabilities.
9. Determines probabilities of simple and compound events.
10. Compares experimental probabilities with theoretical probabilities.
11. Applies the multiplication principle to determine the number of possible outcomes of a situation.

Materials used in preparing the probability unit are discussed on pages 60 and 61. Shepler's (1969) work, A Study of the Development of a Unit in Probability and Statistics for the Elementary School, was especially helpful in identifying appropriate objectives for students in fourth and fifth grades.