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ABSTRACT

The heuristic model and measurement models guiding a proposed seven-year investigation of how children learn to comprehend what they read--and in particular how they comprehend science text--are described in this report. The report first offers a brief description of the heuristic model, which is based upon and extended from studies of effective teaching and includes eight constructs: (1) the abilities possessed by students entering school; (2) instructional materials; (3) classroom management; (4) instructional feedback; (5) instruction in decoding, comprehension, and science; (6) stable home characteristics; (7) home support for literacy and science knowledge; and (8) student ability at the end of kindergarten. The remainder of the report discusses and presents empirical support for the measurement models built for each of the constructs. References, figures and a table of effective behaviors in four stages of instruction are appended. (FL)

CENTER FOR THE STUDY OF READING

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THE HEURISTIC AND MEASUREMENT MODELS DURING A STUDY OF READING COMPREHENSION DEVELOPMENT AND SCIENCE KNOWLEDGE

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Abstract

How do children learn to comprehend what they read? And, how do children learn to comprehend science text? These are the primary questions driving a longitudinal study in progress since 1983, requested by NIE and funded by the Center for the Study of Reading and the National Science Foundation. This report sets forth the heuristic model and measurement models guiding this proposed seven-year investigation to follow two cohorts of children from kindergarten through fifth grade. The constructs that compose this model are: entering student ability; instructional materials characteristics; classroom management; instructional feedback; instruction in decoding, comprehension, and science; stable home characteristics; home support for literacy and science knowledge; and student ability at a second time. This heuristic model is intended to guide each year's data collection.

The Heuristic and Measurement Models During a Study of Reading Comprehension Development and Science Knowledge

How do children learn to comprehend what they read? And particularly, how do children learn to comprehend science text? To answer these questions we first built a heuristic model based upon and extended from studies of effective teaching. This model includes: work focused on changes in student achievement correlated with instructional practices such as classroom management; instructional feedback; decoding and comprehension instruction; materials coverage and characteristics; and home support for literacy and science knowledge. That model appears below.

Insert Figure 1 about here.

We selected these constructs for measurement because of the convergence of findings in the last decade that points to positive correlations for these variables and student outcomes in basic skills. From this heuristic model we next built measurement models for each construct. We hypothesize materials to be outside teachers' control in the sense that individual teachers seldom select their materials, but once materials are purchased, school administrators usually expect them to be used. Also, although teachers may add to or subtract from their materials, they generally use them (Durkin, 1978-79, 1981). We further hypothesize that teachers' classroom management and feedback will affect decoding, reading comprehension, and science instruction. In addition, we expect stable, specific home support for literacy and science to influence student performance.

The next section of this paper presents the measurement models for determining what students knew when entering school that predicted later performance, materials' characteristics, classroom practices that mediate entering ability, and home support for literacy and science knowledge.

Student Ability

Findings From Longitudinal Studies of Reading

Little longitudinal research has focused on reading, and the few studies that have been done have addressed questions such as can children be taught to read in kindergarten, or do children who read early have any long-term advantage in reading comprehension over children who learn to read later? We have, however, identified seven longitudinal studies of beginning readers. These studies are briefly described below.

A few studies have followed children through several grades. Durkin (1966) reported on two groups of students. She began her study in 1958 by testing large groups of incoming first graders. She identified 49 early readers in one school district and 157 children in a second district. Durkin's central question was whether children who could read when they began school would maintain their advantage through the elementary grades. Durkin followed her first group through fifth grade and her second group through third grade. The results of this work showed significant lasting achievement differences for children who could read before beginning school.

McKee, Brzeinski, and Harrison (1966) reported their findings the same year that Durkin published hers. They randomly assigned 4,000 entering kindergarten children from the Denver Public Schools to experimental and control conditions. Children in the experimental group were taught to read in kindergarten. Children in the control group had traditional kindergarten experiences. Further variation in experimental and control conditions continued beyond kindergarten. Children from the kindergarten experimental and control conditions were again randomly assigned to accelerated or regular first grade instruction.

McKee, Brzeinski, and Harrison followed their subjects through fifth grade. The findings from this investigation were: Children who received kindergarten reading and continued accelerated programs outperformed first-grade starting accelerated groups, kindergarten reading children who shifted to regular instruction in first grade, and children who did not receive kindergarten reading.

Durkin (1966) was exclusively interested in children who could read before starting school. McKee, Brzeinski, and

Harrison studied the long-term effects of reading instruction that began in kindergarten and was accelerated through fifth grade. Beck (1973) conducted a study from 1967-1972 which focused on selecting children for reading instruction in kindergarten and comparing those children's reading ability to a matched sample. Over five years, Beck used 4 predictors to select kindergarten children for reading instruction. These predictors were: children's knowledge of letter names, teacher judgment, reading readiness scores, and the children's perceptual abilities. During her study, Beck found that each year teachers selected larger numbers of students for reading instruction. Like McKee, Brzeinski, and Harrison, Beck was primarily interested in finding out if children in first through fifth grades who received reading instruction in kindergarten achieved better in reading than children who had not been taught to read in kindergarten. She found statistically significant differences favoring kindergarten readers at each of five grade levels. Beck stated:

> The combination of no significant difference results of the tests for homogeneity of regression and the 'significant difference' results of the analysis of variance is very important, as it suggests that kindergarten reading instruction positively affects subsequent reading instruction, no matter what the I.Q. (p. 59)

Further support for long-term differences in children's reading achievement after kindergarten reading instruction comes from work with experimental and control groups by Durkin (1970; 1974-1975). These two studies grew from Durkin's earlier research (1966) with children who could read early. Durkin developed a program for four-year-old children, and she followed those children for six years. Durkin's (1974-1975) findings are very similar to Beck's (1973) results.

First, experimental and control children did not differ significantly on I.Q. Second, reading achievement scores were always higher (grades 1-4) for experimental children. These differences were statistically significant at grades 1 and 2, but were not significant at grades 3 and 4. Significant differences were not found for boys and girls once analyses of covariance were computed with intelligence entered as the covariant. Subjects' ages did not correlate with their reading scores.

These five studies addressed broad questions about reading. First, Durkin asked if children who can read before first grade maintain that advantage over children of equal intelligence. Then, McKee, Brzeinski, and Harrison; Beck; and Durkin asked if students could be taught to read in kindergarten if either they were randomly assigned for instruction or selected because of performance other than intelligence. Taken together, these studies provide support for beginning reading instruction in kindergarten, but they shed no light on how children develop reading comprehension ability.

Two additional longitudinal studies focus more discretely on kindergarten and first grade children's abilities that predict later performance in reading. In 1976, Stevenson, Parker, Wilkinson, Hegion, and Fish reported a study of 255 pre-kindergarten children that they followed through third grade. Stevenson and his colleagues were interested in investigating individual differences in cognitive activity associated with effective learning of reading and arithmetic in elementary school. They undertook this study because they believed that better understanding of cognitive ability could lead to preschool programs that could enhance students' later performance by preventing failure in basic skills. Stevenson and his colleagues developed a battery of measures to administer to children prior to kindergarten. These measures included 11 cognitive and 14 psychometric tasks as well as kindergarten teachers' ratings on 13 additional variables.

They found that fewer than half the cognitive tasks correlated significantly with reading achievement, and that the most predictive psychometric tasks dealt with words and letters. The children's pre-kindergarten scores on letter naming and the visual-auditory version of the paired associates test were the best predictors of reading comprehension in second and third grade, though verbal recall was also a good predictor in second grade. These pre-kindergarten tasks were consistently better predictors than teachers' ratings. Similar results have also been reported by Dykstra (1967), Barrett (1965), and Durkin (1974-1975).

Lesgold, Resnick, and Hammond (1984) focused their longitudinal study on one subskill of reading, rapid word recognition. They studied children in a global curriculum, a method by which students were expected to recognize and understand whole words simultaneously, and a code-emphasis curriculum wherein students learned symbol-sound correspondences and blending skills intended to facilitate word recognition. The theoretical basis for this research is that students have limited capacities for processing information. Therefore, a beginning reading approach that results in "automaticity" (LaBerge & Samuels, 1977) of word recognition will then allow students to focus attention on comprehending what they read.

Lesgold and his colleagues designed a study to reflect, "a careful plotting of the actual trajectories of reading skill development in the primary grades" (p. 4) in order to understand how word recognition develops and how the development of word recognition ability is related to reading comprehension. The Lesgold et al. work departed from the studies described earlier because it (a) had subjects from two distinct curricula, (b) tested students as they reached specific points in their curriculum, and (c) measured word reading skills in terms of reaction times for word recognition and classification of word meanings. The primary finding from this study was that word processing speed and reading comprehension measures showed greater predictive paths from early word processing to subsequent comprehension than vice versa. Therefore, Lesgold and Resnick (1982) concluded that during beginning reading (the first two years of instruction) children must develop word processing speed in order to comprehend what they read. In addition, the ability to comprehend what one reads builds from one year to the next, so word processing as an independent skill declines. These findings support Chall's (1983) description of the first two stages of reading development where students are at first very focused on figuring out print and then become unglued from it. Chall (1983) labeled the first stage decoding and the second stage, fluency.

In summary, the major findings from these seven studies suggest that (a) children who read early maintain this advantage through the middle elementary grades, (b) children can be taught to read before first grade, (c) early readers continue to perform higher on measures of reading comprehension than children taught to read later if they have accelerated reading programs after kindergarten, (d) children's abilities to identify letters and word configurations prior to kindergarten instruction are better predictors of later reading comprehension ability than general cognitive or psychometric tasks, and (e) word processing ability in early grades results in reading comprehension ability later.

Our study builds on these results by measuring students' listening ability and by providing detailed information about the role of classroom instructional processes and children's experiences with various reading materials in the development of reading comprehension ability and the acquisition of understanding and concepts in science.

The fourth and fifth findings from the studies just cited greatly influenced the choice of assessment devices for use at Time 1, fall of the kindergarten year for entering students. Figure 2 shows the four types of ability measured. Letter knowledge was measured for both letter names and letter sounds. Word reading ability was examined with word endings, word families, and a test of reasonably high frequency sight words. Language ability was measured with a test of vocabulary, a set of analogies, statement repetition items, classification pairs, and a measure of the children's statement production ability when presented with a series of four pictures and asked to tell a story about them.

Insert Figure 2 about here.

The final construct of ability measured was students' listening comprehension ability, because Humphreys and Davey (1983) have found listening comprehension ability to predict reading comprehension performance two years later.

Instructional Materials

Content Covered

We hypothesize that materials affect management and feedback as well as decoding, comprehension, and science instruction because materials at least set the boundaries that define the content to be covered during instruction. Teachers must work to cover the materials.

Content covered is closely linked to Carroll's (1963) concept of opportunity to learn. A variety of measures of content covered have been used. These include both measures of the quantity of material covered (e.g., the number of books read, the number of basals completed, or the number of textbook pages covered) and the degree of match or overlap between the material covered and the items on the test used to measure student achievement. The degree of match has been measured by teacher ratings of the proportion of students who have had an opportunity to learn the content covered by each item on a test (cf. Husen, 1967) and by analyses of the overlap between curriculum and instructional materials and items on a test (cf. Leinhardt, 1983). Despite the diversity of the measures used, content covered has consistently been found to be positively related to student achievement and to student gains in achievement.

The next section of this paper presents the findings from previous research on instructional materials and their effects on student achievement. This review is limited to studies that included a systematic analysis of instructional materials before explaining student achievement.

Barr (1973-1974; 1975), Good, Grouws, and Beckerman (1978), Barr, Dreeben, and Wiratchai (1983), and Dreeben (1984) have studied the content of social studies curricula, basal reading programs, and math series. In all of these studies, significant relationships were found between content covered and student achievement. These studies support McDonald (1976) who stated, "If students have not been taught . . . some . . . content or procedure, they simply do not do well on those portions of the test relevant to the topic" (p. 27).

Despite the charge from Cronbach (1975) and Guba (1978) to do more context-sensitive evaluations, few researchers have even carefully noted, much less analyzed, the instructional materials used in classrooms studied with naturalistic inquiry methods.

Barr (1973-1974, 1975), Meyer (1982), and Barr, Dreeben, and Wiratchai (1983) have carefully analyzed and then controlled or quantified content covered in order to study the effects of either teaching behavior feedback (Meyer, 1982) or the mediating effects of a group's ability on coverage.

We propose to build upon the work completed on content covered by quantifying the vocabulary and concepts of the reading and science texts used by our subjects and to derive amounts of practice within these materials. We anticipate that simple counts of reading vocabulary or scientific domains describe but one aspect of the materials and that particularly for groups of lower ability it is important to havr repeated practice on similar examples in order to promote mastery of a concept.

Furthermore, we propose to extend previous analyses of reading and science materials in order to determine how the materials are organized to prepare students to read by building or activating background knowledge and then by sequencing questions or directive instructions about the text.

Concepts and text characteristics: Reading and science programs. These constructs (depicted in Figure 3) are: concepts and skills presented in the basal reading programs including letter names, letter sounds, blending, rhyming, whole-word reading, and the amount of practice allocated to each concept or skill. We will also assess characteristics of the reading and science texts. These assessments will include measures of vocabulary size, number of domains taught, text length, and text characteristics that make them easier or harder for students to read.

Insert Figure 3 about here.

Independent practice materials. We will further analyze independent practice reading materials to determine their phonics practice emphasis as well as their text emphasis. Are words presented in isolation or do students read connected text? The primary goal of these analyses is to describe quantifiably the contents of the instructional materials.

Comprehension instruction and practice: Reading and science. How do these materials build instruction to focus students' attention on the text? To measure this we will look at the questions designed to activate students' background knowledge; questions answered either explicitly or implicitly in the text; questions focused on what are often called "story grammars" (Brewer & Hay, 1981; Ringler & Weber, 1984); and questions directed to other characteristics of narrative prose such as the setting, plot, character, theme, and so on. Finally, we will count the number of procedural instructions, such as "Draw a line from the dog under the porch to the cat," and in science, particularly, but not exclusively, the number of practical applications of concepts that students do as well as instructions for poetry, plays, or other activities.

Assessment: Reading and science. Finally, we will count the number of review questions to measure how student performance is monitored as well as a program's provisions for assessment such as end-of-unit, or book tests.

Instructional Practices

Management

Many factors intertwine to form accurate and cohesive pictures of how classrooms are managed. Several correlational studies (e.g., Stallings & Kaskowitz, 1974; Brophy & Evertson, 1976; Fisher, Berliner, Filby, Marliave, Cahen, & Dishaw, 1980), experimental work (Anderson, Evertson, & Brophy, 1979; Good, Ebmeier, & Beckerman, 1978; Good & Grouws, 1979), as well as Barr, Dreeben, and Wiratchai's (1983) results from research on grouping practices, instructional materials, and time allocations point to the type of managerial decisions and practices teachers establish before they even begin to teach. These researchers have found consistently positive relationships between these characteristics of student achievement. Among these variables are: grouping for instruction and consequential pacing of students through materials because of the nature of those groups; total time allocated for instruction and then the distribution of this time to whole-class, small groups, or individuals; and students' engagement and success rates. The next portion of this paper will briefly describe findings from previous research to support these instructional practices.

Grouping. Seventy-seven percent of all teachers group for instruction (Findley & Bryan, 1975), and recent research on grouping suggests that grouping practices which were formerly most prevalent in the middle and upper grades have filtered down to the lower grades (Findley & Bryan, 1975). Despite the prevalence of grouping practices, few studies have focused on the distribution of students to classes (e.g., grouping decisions frequently made by principals with teachers' recommendations after kindergarten and before beginning first grade) and subsequent intra-classroom grouping by teachers. Borg (1965) pointed out that grouping often results in differing instructional treatments as teachers adjust their paces to the ability of their groups.

Over half a century ago three studies (Burr, 1931; West, 1933; Hartill, 1936) demonstrated that substantial variation remains in classrooms even after inter-class grouping. Work by Dahloff (1971), Barr (1980), Barr, Dreeben, and Wiratchai (1983), and most recently, Allington (1984) illustrate the effects of grouping on progress through, or coverage of, curricula. This link between group formation and coverage is of central interest in this study because Barr, Dreeben, and Wiratchai's (1983) primary finding is that the mean aptitude of a group powerfully influences teachers' instructional pacing, and accounts for 46% of the variance in coverage. Allington's work (1984) illustrates this point dramatically by documenting that poor readers in grades 1, 3, and 5 read roughly half the total words that "good" readers in the same grades read. These poor readers averaged less than 8% words read silently in first grade, and 50% for third and fifth grades when compared to good readers in less than a five day period despite similar amounts of oral reading during the same period. Thus, there is converging evidence that it is important to study grouping because of the indirect effect that grouping has on content coverage. To illustrate further the ties between instructional materials, grouping, and content coverage, Barr, Dreeben, and Wiratchai (1983) found that the difficulty of the instructional materials explains another 15% of the variance of coverage.

Time and student engagement. Numerous studies have focused on time allocated to instruction for literacy. Stallings and Kaskowitz (1974) found students in the three highest-performing Follow Through models they studied were spending about 50% more time on reading activities than students in other models. Subsequent studies have demonstrated that the amount of time allocated for instruction and the measured engagement rate of students during that time may be quite different. In fact, Rosenshine (1979) described two teachers using the same curriculum. One teacher allocated half an hour to instruction while the second teacher allocated twice as much time. But, the first teacher exhibited what Brophy (1983) subsequently described as "withitness" and maintained an 80% engagement rate while the other teacher had only 65% engagement. Rosenshine illustrated that a simple comparison of "engaged minutes" in the two classrooms during a two and a half month study resulted in greater content coverage in the second classroom. Grouping practices were not reported in this research, so one cannot evaluate the effects of the groups' abilities on coverage.

Results of the Beginning Teacher Evaluation Study (Fisher et al., 1978) also demonstrated the importance of considering more than content covered or the amount of time allocated to a specific content area. Classes were found to vary, not only in the amount of time allocated to an area of study, but in the rate at which students were engaged during that time and in rate of errors made. Furthermore, students' engagement in learning and the rate of student errors (or the converse, student success rate) were both shown to have strong relationships with student gains in achievement.

As concluded by authors of several recent reviews (e.g., Brophy & Good, 1986; Good, 1983; Rosenshine & Stevens, 1984), research on classroom instruction has made great progress in the past decade. There is converging evidence from a number of correlational and experimental studies that gains in student achievement are related to three variables that Rosenshine and Stevens (1984) have labeled "indices of instructional effectiveness." These three indices are content covered, academic engaged time, and student success rate.

It is notable that none of these three indices is an instructional variable in the same sense as variables such as grouping procedures or feedback. These indices may be more appropriately thought of as mediating constructs or even, as suggested by Rosenshine and Stevens, as consequences of instruction rather than ways of organizing or delivering instruction. Nonetheless, content covered, academic engaged time, and student success rate have been found to have relatively strong relationships with gains in student achievement. We have included measures of: time allocated for reading and science instruction; students' engagement rate while not directly supervised by their teachers; ability of students grouped for instruction; teacher-directed instructional time versus independent work; teacher-directed time in large group versus small-group instruction; the success level of student performance on independent work; the rate at which students progress through their curricula; and the teachers' allocation of turns to the whole class, small groups, and individuals, as well as the teachers' frequencies of praise and corrective statements to individuals or small groups to measure classroom management.

Insert Figure 4 about here.

Instructional Feedback

Teachers initiate interactions with students. They ask instructional questions or give directions. Students either respond or remain silent, and their responses are either correct or incorrect What happens next? Rosenshine (1979) identified feedback to students that is immediate and academically oriented as one of the nine characteristics he describes collectively as "direct instruction."

About the same time that Rosenshine's work appeared, Gersten (1979) studied the effectiveness of a group of teachers and paraprofessionals implementing a direct instruction model.

Gersten measured teachers' pacing, the rate of teacher/student interactions, signals and techniques to keep homogeneous small groups responding together, following formats, teachers' adherence to their scripted lessons and correction procedures, and teachers' responses to wrong answers. First, Gersten documented the teachers that were using these four techniques. Next, he correlated the teachers' performance on these techniques with student achievement. He found that teachers who paced instruction rapidly, maintained high rates of student accuracy and corrected wrong responses produced the highest student gains. He also found that of these four techniques, correction procedures and high rates of student accuracy (which no doubt went hand in hand) were the most "sophisticated" teaching behaviors and therefore took longest for teachers to master.

There is limited empirical support for the positive effects of teacher's feedback to wrong responses. The First Grade Reading Group Study (Anderson, Evertson, & Brophy, 1979) provides the richest data source during beginning reading instruction. First, Anderson, Evertson, and Brophy (1978) completed a correlational study with thirty-one teachers. From these data they produced an instructional model (Anderson, Evertson, & Brophy, 1979) that focused on management of the group as a whole (16 principles) and instructional feedback to students' answers (6 principles). In the experimental study, Anderson et al. (1979) described feedback principles. Teachers were to: (a) wait for a child to respond, but indicate a response was expected if a child failed to respond after a brief wait; (b) indicate when a child was wrong; (c) give the answer if the question was factual, provide clues if the answer could be reasoned out, or furnish the answer if the child could not produce a correct answer after hearing clues; (c) acknowledge correct answers--often by repeating good responses; (e) praise moderately; and (f) criticize specifically.

In this experimental study twenty-seven first grade teachers received a manual describing the instructional model and limited inservice training in its application. Significant effects were found for treatment teachers using sustained feedback, though the model did not describe or prescribe how teachers were to respond to wrong responses. Most sustained feedback led to improved answers, and process feedback (responses to students that led them through steps to come up with the correct answer) also led to higher student performance though teachers seldom used process feedback. Treatment teachers also gave more specific praise to students, though overall they praised students less than the control teachers. Neither group criticized students frequently. There were three other interesting differences between these treatment and control teachers that complement Gersten's (1979) findings. Treatment teachers had higher percentages of correct answers (73% correct as compared to 66%), fewer instances of students failing to respond, and fewer reading errors in their classes.

We have empirical support for the effects of teachers' instructional feedback to wrong responses from one more study. Meyer (1982) found that middle grade poor readers to whom teachers simply told the correct word after word identification errors in the first 70 lessons of Corrective Reading (Engelmann, Johnson, Becker, Meyer, Carnine, & Becker, 1978) performed as well on individually administered criterion-referenced and norm-referenced reading measures as comparable groups to whom teachers taught complex word analysis corrections. The error rates for both groups in Meyer's study were low. In fact, students averaged fewer than 3 errors per 100 words of text. Therefore, the low error rate for both groups might account for lack of impact from the more complex word analysis procedures.

Of Rosenshine's nine characteristics of direct instruction, monitoring and feedback are two teaching behaviors that we know very little about. In fact, there has been little research on feedback reported in the last twenty years, despite a comprehensive review of findings related to general feedback principles that appeared more than two decades ago (Lumsdaine, 1963) in the First Handbook of Research on Teaching (N. L. Gage, Ed.). Lumsdaine's (1963) review concluded with remarks to researchers and teachers about the importance of feedback. In fact, one of his conclusions was that teachers should make overt for the learner the process needed to complete a task correctly.

In light of Lumsdaine's conclusions and the handful of studies specifically related to feedback during basic skills instruction cited above, we included measures of a number of different types of teacher feedback which cluster into three categories: feedback after correct responses; feedback after incorrect responses; and feedback to written work. The measurement model for feedback appears in Figure 5.

Insert Figure 5 about here.

After correct responses. When students respond correctly, teachers most often either say nothing, repeat the student response as if to reconfirm it, or praise with words such as "good," or "terrific."

After incorrect responses. After students have given wrong responses, teachers respond in one of three ways. They may encourage students by giving them hints or suggestions to "take another look," to re-examine their answers. Or, they may ask a student to elaborate upon his or her answers. All of these types of feedback encourage a student in some way to modify his or her answer.

Just as some types of feedback encourage students, other types of feedback terminate a teacher's interaction with students. For example, a teacher might simply ignore a wrong response, give the correct answer, call on another student, or negate the first student's response by saying, for instance, "No, the word is not 'went.'" This teacher might then direct the group to the next word or sentence.

Regardless of the specific words used, the result of these instances of feedback is that the teacher goes on to another interaction and perhaps even another student. None of these forms of feedback continues until students produce a correct response.

Quite different feedback strategies sustain a teacher's interactions with an individual or group of students in order to get the correct answer. The simplest thing a teacher might do to sustain an interaction is to repeat the question or direction to the student who made the mistake. A more elaborate type of sustained feedback occurs if a teacher demonstrates the process for working through to a correct answer or somehow breaks the task down into smaller parts and then puts the parts back together. We identify both of these examples of feedback as sustained feedback. For example, while reading a sentence a student might misidentify the word "went." A teacher who asks, "What's the sound of the first letter in that word?" and then directs the student to sound out the word, and then asks again what the word is has led the student through several steps in order to identify the word correctly and has given sustained feedback until he or she got the correct answer.

With another type of sustained feedback, a teacher might give students a rule that applies to the problem they are working on to help them come up with the answer.

Feedback on written work. A final type of feedback is that which teachers give to work students complete either on their own or after some preparation with the teacher. This is the feedback teachers give by grading papers. We collect and analyze student work to categorize it as literacy related text/non-text or science related. When checking student work we also compare a student's true score to the score the teacher gave.

Decoding, Comprehension, and Science Instruction

Given the strength of the relationship of content covered, academic engaged time, and student success rate with gains in student achievement, it is important that studies of classroom instruction attend to these constructs. However, future advances in knowledge about instructional effectiveness will require research that goes beyond these global constructs. This is so, in part, because of the nature of these constructs. They are, as was previously indicated, mediators rather than directly observable teacher behaviors and relatively little is known about teacher behavior that results in increased coverage of content or student engagement. Nor is it clear that the ideal student success rate is a constant regardless of subject matter, the developmental level of a student, or a student's stage of learning. The most effective success rate may be substantially different in kindergarten than in grade 5, for example.

There is, of course, a large body of research relating teacher behavior variables to student achievement. Some of this research is, at least, suggestive with regard to the types of instructional practices that are likely to increase content coverage and enhance student engagement. Some of the relevant variables (e.g., grouping practices, teacher-directed instruction, and use of questions and feedback) have a long history. However, more emphasis has been placed on quantity than on quality of instruction and to date little attention has been paid to the specific instructional context within which the data were collected. Furthermore, simple counts of the number of questions or of the number of times various types of feedback is given provide little information about effective sequencing within different contexts. While simple frequencies of interactions might be good predictors of student achievement in decoding, informed opinion suggests that successful teaching characteristics for reading comprehension might be much more complicated. Yet leaders in the field of research on teaching (e.g., Brophy & Good, 1986; Good, 1983) have strongly emphasized the need to give greater attention to quality of instruction and to analyses of instructional sequences.

At a global level, research "has shown that effective teaching is characterized by a predictable sequence of demonstration, guided practice, feedback and corrections, and independent practice" (Rosenshine & Stevens, 1984, p. 788). Within this general sequence, Rosenshine and Stevens have also abstracted a description of behaviors in each stage of instruction that research has suggested lead to more effective instruction. Their conclusions regarding effective behaviors are summarized in Table 1.

The summary in Table 1 provides a rich context for organizing and analyzing classroom observation variables. It also provides a framework for the development of qualitative indicators of classroom instruction and for planning sequential analyses.

Insert Table 1 about here.

We therefore hypothesize that during decoding, comprehension, and science instruction effective teachers will generally follow these stages of demonstration, guided practice, feedback/corrections, and independent practice, and that the sequence and frequency of interactions will vary dependent upon the type of skill the teacher is working on and the stage of instruction for the group. Long chains of letter sound practice interrupted only by feedback that result in a high success rate of student performance may yield high student achievement for letter-sound knowledge, for example. But, effective sequences during reading comprehension instruction might begin with questions to build or activate background knowledge and then move to a series of text explicit or implicit questions to check students' understanding of information in the text. Effective sequences might conclude with summaries or other kinds of interactions to demonstrate knowledge of what Brown and Day (1983) refer to as the "gist." The measurement models for decoding, comprehension, and science instruction appear respectively in Figures 6 and 7.

Insert Figures 6 and 7 about here.

Home Support for Literacy and Science Knowledge

What do parents do to support literacy and science knowledge in their children? There are three general lines of research that address this question. This research is on familial influences of cognitive development and student achievement as well as results found from studying two quite different samples of parents: parents of students in compensatory education programs and parents of students who were reading before they started school.

Carter (1983) reported data from interviews with about 15,000 parents in order to describe the "typical" home environment of elementary school-age children. He found that the average elementary school child comes from a two-adult family with parents around age 35. These parents are white and live in a single family home. They are high school graduates. These parents report that elementary school age children play for about two hours each day, watch television for another two hours, and also spend another hour each on chores, reading for pleasure, and studying. Parents are generally involved in school activities and rate their children's schools as "excellent."

Carter correlated these general characteristics of home environment to student achievement and found low to moderate negative correlations for family size, ethnicity, and the ratio of occupants to dwelling rooms. He found low to moderate positive correlations for two-adult families and head of household's level of education. Next, we'll report global findings from the rich tradition of research on more specific family influences on student achievement.

Support for the family's influence on general cognitive development and student achievement is generally attributed to four areas: biological factors; environmental factors; status variables; and family processes. Most simply put, researchers generally agree that biological and environmental factors interact to influence intelligence. Considerable disagreement rages, however, about the magnitude of the effect of each of these variables. Scarr and Weinberg (1978) studied adopted children and their biological and adoptive parents and concluded that 40-70% of the variance in an individual's IQ score is explained by genetic factors. Studies involving parental interviews and observational studies of parents and their children (Hay & O'Brien, 1983; Wilson, 1983) have resulted in defining terms such as the intellectual climate.

Environmental variables found to be related to cognitive development and school achievement include moderate stimulation (Wachs & Gruen, 1982), personal space (Wachs, 1979), and high rates of older siblings or adults (Zajonc, 1976, 1983), with demonstrated lower performance for students from single-parent homes (Herzog & Sudia, 1973), though more recent work (Hetherington, Camara, & Featherman, 1981; Shinn, 1978) suggests less clear evidence that children from single-parent homes have lower cognitive ability or school achievement. Teacher bias against children from single-parent homes has been found in at least one study (Santrock & Tracy, 1978). The effects of maternal employment appear to be positive for children from low socioeconomic status families (Rieber & Womach, 1967) and inconclusive for middle and working class children (Gold & Andres, 1978).

Socioeconomic status by itself has not been found to explain variance in student achievement (Henderson, 1981), although a number of researchers argue that processes in these families, but not their socioeconomic stat·s alone, accounts for lower student achievement. A number of other studies have focused on mothers' instructional strategies (Hess & Shipman, 1965) and several intervention programs (e.g., Gordon, 1977; Weikart & Lambie, 1968) grew from this work in attempts to teach low-income mothers instructional strategies to use with their children. Although many researchers (e.g., Scott-Jones, 1984) acknowledge the continuing roles of parents as teachers, others (Scribner & Cole, 1973; Henderson, 1981) suggest that parents from different socioeconomic groups focus on different domains and that the domains of poor parents less closely match school curricula than the choices of more affluent parents. Thus, these choices may result in differential student achievement. These constructs appear in Figure 8.

Insert Figure 8 about here.

Home support for literacy was of central interest in Durkin's work (1966) on children who read early. In this study Durkin identified children already reading when they started school. She then interviewed parents to find out what these families had done that might have produced these early readers. Durkin's subjects' parents identified 28 qualities in their children with persistence, perfectionistic, high-strung, good disposition, and serious the most frequently mentioned descriptors. Forty-two of Durkin's 49 subjects reported that a parent (almost always the mother) had taught them to read. Descriptions of the early readers' home reading instruction varied from being told words (31%) to being taught how to sound out words (64%). A few children declared they taught themselves.

Parents of early readers also reported doing a variety of activities that are indirectly related to reading. Among these activities were: reading to children, buying books, helping child learn to print, helping older children with school work as the younger child watched, buying readers and school-like workbooks. In addition, Durkin's early readers reported they were motivated to learn to read primarily by four things: being read to at home; wanting to keep up with older siblings; having reading materials; and having blackboards available at home. Many early readers first became interested in writing and spelling and then in reading.

How might these characteristics also relate to young children's knowledge of science? The relationship between home instruction and science learning has been studied far less rigorously than home support for literacy, so the answer is much more tentative. Steinkamp and Maehr (1983) studied 255 correlations reported in sixty-six articles and concluded that girls' and boys' science achievement is positively related to affect, though weakly. Cognitive ability, on the other hand, correlated much more strongly with science achievement: with boys achieving slightly higher than girls, particularly in areas of science generally thought of as "more masculine" (Walberg, 1967) (physics or engineering, for example). Weitzman and Rizzo (1974) concluded that little boys have been found to engage more actively in taking machines and other things apart whereas girls self-select other kinds of play. But, we can find no research that identifies what parents do that directly or indirectly results in these differences. Out of school experience is hypothesized to explain a great deal of variance in student achievement in science by fourth or fifth grade because there is mounting evidence that students receive little formal <u>or</u> informal science instruction in school (Kelly, 1978).

Whenever researchers find substantial differences in student achievement that cannot be explained either because they exist when students begin school (as with Durkin's 1966 study of ea: readers) or as in science where there is little instruction in school, it becomes increasingly essential to attempt to measure and track systematically what subjects are doing out of school. Although students spend over 15,000 hours in school from kindergarten through high school, that is less than 2% of their total lives. What are they doing the rest of the time?

We hypothesize that it is imperative to measure at least four aspects of young students' lives to gain insight on why and how they have different achievements in science. First, we argue that both directly and indirectly parents teach their children to calibrate and observe the world around them. Second, parents provide and encourage experiences with and for their children that provide exposure to subjects that children may later pursue on their own. Third, parents control resources, especially books and experiences particularly for young children that may stimulate interest in science while informally building students' background knowledge about several scientific domains. Finally, students themselves by at least age 5 begin to choose activities to pursue when given opportunities that may predict later achievement in science. These constructs are illustrated in Figure 9.

Insert Figure 9 about here.

Student Ability, Time 2

What types of student ability at the end of kindergarten will predict later student achievement in reading comprehension and science, and how was student performance at the end of the year mediated by what went on in those students' homes and classrooms? The remainder of this paper will be limited to a short description of measuring student ability at time 2, the end of kindergarten. Measurement at Time 2 was expanded from the four constructs measured at Time 1 (Letter Knowledge, Word Reading Ability, Oral Language Ability, and Listening Comprehension Ability) to include a measure of reading comprehension, a measure of metacognition (for particularly high-performing students as identified by their reading comprehension scores), and a measure of general science knowledge. Measurement of Letter Knowledge, Word Identification, and Word Reading Ability as well as the measure of Listening Comprehension Ability was either the same instrument used for fall testing or the next level of the same instrument.

The measures of Reading Comprehension Ability and Science Knowledge were added in order to provide data on these emerging and relevant areas of student achievement. The measurement model for student ability, Time 2, appears as Figure 10.

Insert Figure 10 about here.

In summary, our goal was first to develop a heuristic model to represent the major variables believed to be integral to student development of reading comprehension ability and science knowledge. This paper has attempted to present the empirical support for both the heuristic and measurement models driving our research. We expect to refine these models during the remaining five and a half years of this study.

References

Allington, R. L. (1984). Content coverage and contextual reading in reading groups. *Journal of Reading Behavior*, *16*, 2.

Anderson, L., Evertson, C., & Brophy, J. (1978). *The first-grade reading group study: Technical report of experimental effects and process-outcome relationships* (R&D Report No. 4070). Austin, TX: Research and Development Center for Teacher Education, University of Texas at Austin.

Anderson, L. M., Evertson, C. M., & Brophy, J. E. (1979). An experimental study of effective teaching in first-grade reading groups. *Elementary School Journal*, *79*, 193-223.

Barr, R. (1973-74). Instructional pace differences and their effect on reading acquisition. *Reading Research Quarterly*, *9*, 526-554.

Barr, R. (1975). How children are taught to read: Grouping and pacing. *School Review*, *83*, 479-498.

Barr, R. (1980, April). *School, class, group, and pace effects on learning*. Paper presented at the meeting of the American Educational Research Association, Boston.

Barr, R., Dreeben, R., & Wiratchai, N. (1983). *How schools work*. Chicago: University of Chicago Press.

Barrett, T. C. (1965). Visual discrimination tasks as predictors of first-grade reading achievement. *Reading Teacher*, *18*, 276-282.

Beck, I. L. (1973). A longitudinal study of the reading achievement effects of formal reading instruction in the kindergarten: A summative and formative evaluation. Unpublished doctoral dissertation, University of Pittsburgh.

Borg, W. R. (1965). Ability grouping in the public schools. Journal of Experimental Education, 34, 1-97.

Brewer, W. F., & Hay, A. (1981, April). Children's understanding of the author's point of view in stories. Paper presented at the meeting of the Society for Research in Child Development, Boston.

Brophy, J. E. (1983). Classroom organization and management. The Elementary School Journal, 4, 265-285.

Brophy, J. E., & Evertson, C. M. (1976). Learning from teaching. Boston: Allyn & Bacon.

Brophy, J. E., & Good, T. L. (1986). Teacher behavior and student achievement. In M. Whitrock (Ed.), Handbook of research on teaching (3rd ed.) (p. 328-375). New York: Macmillan.

Brown, A. L., & Day, J. D. (1983). Macrorules for summarizing texts: The development of expertise (Tech. Rep. No. 270). Urbana: University of Illinois, Center for the Study of Reading.

Burr, M. Y. (1931). A study of homogeneous grouping. New York: Teachers College Bureau of Publications.

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

Carter, L. F. (1983). A study of compensatory and elementary education: The sustaining effects study. Prepared by the System Development Corporation for the Office of Program Evaluation.

Chall, J. S. (1983). Stages of reading development. New York: McGraw-Hill.

Cronbach, L. J. (1975). Beyond two disciplines of scientific psychology. American Psychologist, 30, 116-127.

Dahloff, U. S. (1971). Ability grouping, content validity, and curriculum process analysis. New York: Teachers College Press.

Dreeben, R. (1984). First grade reading groups: Their formation and change. In P. L. Peterson, L. C. Wilkinson, & M. Hallinan (Eds.), The social context of instruction. New York: Academic Press.

Durkin, D. (1966). Children who read early. New York: Teachers College Press, Columbia University.

Durkin, D. (1970). A language arts program for pre-first grade children: Two-year achievement report. Reading Research Quarterly, 5, 534-565.

Durkin, D. (1974-75). A six year study of children who learned to read in school at the age of four. Reading Research Quarterly, 1, 9-61.

Durkin, D. (1978-79). What classroom observations reveal about reading comprehension instruction. Reading Research Quarterly, 16, 481-533.

Durkin, D. (1981). Reading comprehension instruction in five basal reader series. Reading Research Quarterly, 16, 515-544.

Dykstra, R. (1967). The use of reading readiness tests for prediction and diagnosis: A critique. In T. C. Barrett (Ed.), The evaluation of children's reading achievement. Newark, DE: International Reading Association.

Engelmann, S., Johnson, C., Becker, W., Meyer, L., Carnine, L., & Becker, J. (1978). The corrective reading programs. Chicago: Science Research Associates.

Findley, W., & Bryan, M. (1975). The pros and cons of ability grouping. Phi Delta Kappa Fastback #66, Phi Delta Kappa Educational Foundation.

Fisher, C. W., Berliner, D. C., Filby, N. N., Marliave, R., Cahen, L. S., & Dishaw, M. M. (1980). Teaching behaviors, academic learning time and student achievement: An overview. In C. Denham & A. Lieberman (Eds.), Time to learn. Washington, DC: USOE/NIE Printing.

Fisher, C. W., Filby, N. N., Marliave, R., Cahen, L. S., Dishaw, M. M., Moore, J. E., & Berliner, D. C. (1978). _Teaching behaviors, academic learning time, and student achievement: Final report of Phase III-B, Beginning Teacher Evaluation Study_, San Francisco, Far West Educational Laboratory for Educational Research and Development.

Gersten, R. M. (1979). _Interim report and summary proposal: Study of implementation of an innovative educational model in a large urban school district_ (Technical Report 79-1). Unpublished manuscript, University of Oregon.

Gold, D., & Andres, D. (1978). Development comparisons between ten-year-old children with employed and non-employed mothers. _Child Development_, _49_, 75-84.

Good, T. L. (1983, April). _Classroom research: A decade of progress_. Paper presented at the annual meeting of the American Educational Research Association.

Good, T., Ebmeier, H., & Beckerman, T. (1978). Teaching mathematics in high and low SES classrooms: An empirical comparison. _Journal of Teacher Education_, _29_, 85-90.

Good, T., & Grouws, D. (1979). The Missouri mathematics effectiveness project. _Journal of Educational Psychology_, _71_, 355-362.

Good, T. L., Grouws, D. A., & Beckerman, T. M. (1978). Curriculum pacing: Some empirical data in mathematics. _Journal of Curriculum Studies_, _10_, 75-82.

Gordon, I. J. (1977). The parent education follow-through program. Chapel Hill: University of North Carolina.

Guba, E. G. (1978). Toward a methodology of naturalistic inquiry in educational evaluation. Los Angeles: CSE Monograph Series in Evaluation, Center for the Study of Evaluation.

Hartill, R. M. (1936). Homogeneous grouping. New York: Teachers College Bureau of Publications.

Hay, D. A., & O'Brien, P. J. (1983). The la trobe twin study: A genetic approach to the structure and development of cognition in twin children. Child Development, 54, 317-330.

Henderson, R. W. (1981). Home environment and intellectual performance. In R. W. Henderson (Ed.), Parent-child interaction. New York: Academic Press.

Herzog, E., & Sudia, C. E. (1973). Children in fatherless families. In B. Caldwell & H. Ricciuti (Eds.), Review of child development research. Chicago: University of Chicago Press.

Hess, R., & Shipman, V. (1965). Early experience and the socialization of cognitive models in children. Child Development, 36, 869-888.

Hetherington, E. M., Camara, K. A., & Featherman, D. L. (1981). Cognitive performance, school behavior, and achievement of children from one-parent households. Washington, DC: National Institute of Education.

Humphreys, L. G., & Davey, T. C. (1983). Anticipation of gains in general information: A comparison of verbal aptitude, reading comprehension, and listening (Tech. Rep. No. 282). Urbana: University of Illinois, Center for the Study of Reading.

Husen, T. (Ed.) (1967). International study of achievement in math: A comparison of twelve countries (Vol. II). New York: Wiley & Sons.

Kelly, A. (1978). Girls and science: An international study of sex difference in school science achievement. Stockholm: Almqvist & Wiksell International.

LaBerge, D., & Samuels, S. J. (1977). Basic processes in reading. Hillsdale, NJ: Erlbaum.

Leinhardt, G. (1983). Overlap: Testing whether it is taught. In G. F. Madous (Ed.), The courts, validity, and minimum competency testing. Boston: Klwer-Nighoff, Publishers.

Lesgold, A. M., & Resnick, L. B. (1982). How reading disabilities develop: Perspectives from a longitudinal study. In J. P. Das, R. Mulcahy, & A. E. Wall (Eds.), Theory and research in learning disability. New York: Plenum.

Lesgold, A., Resnick, L. B., & Hammond, K. (1984, March). Learning to read: A longitudinal study of work skill development in two curricula. Learning Research and Development Center, University of Pittsburgh.

Lumsdaine, A. A. (1963). Instruments and media of instruction. In N. Gage (Ed.), First handbook of research on teaching. Chicago: Rand McNally.

McDonald, F. J. (1976). Research on teaching and its implications for policy making: Report on phase II of the beginning teacher evaluation study. Princeton, NJ: Educational Testing Service.

McKee, P., Brzeinski, J. E., & Harrison, M. L. (1966). The effectiveness of teaching reading in kindergarten (Cooperative Research Project No. 5-0371). Denver Public Schools and Colorado State Department of Education.

Meyer, L. A. (1982). The relative effects of word-analysis and word-supply correction procedures with poor readers during word-attack training. Reading Research Quarterly, 4, 544-555.

Rieber, M., & Womach, M. (1967). The intelligence of preschool children as related to ethnic and demographic variables. Exceptional Children, 34, 609-614.

Ringler, L., & Weber, C. K. (1984). A language-thinking approach to reading. New York: Harcourt, Brace, Jovanovich.

Rosenshine, B. V. (1979). Content, time, and direct instruction. In P. L. Peterson & H. J. Walberg (Eds.), Research on teaching. Berkeley, CA: McCutchan.

Rosenshine, B., & Stevens, R. (1984). Classroom instruction in reading. In P. D. Pearson, R. Barr, M. L. Kamil, & P. Mosenthal (Eds.), Handbook of reading research. New York: Longman.

Santrock, J. W., & Tracy, R. L. (1978). The effects of children's family structure status on the development of stereotypes by teachers. Journal of Educational Psychology, 70, 754-757.

Scarr, S., & Weinberg, R. A. (1978). The influence of family background on intellectual attainment. American Sociological Review, 78, 674-692.

Scott-Jones, D. (1984). Family influences on cognitive development and school achievement. In E. W. Gordon (Ed.), Review of research in education (Vol. 11). Washington, DC: American Education Research Association.

Scribner, S., & Cole, M. (1973). Cognitive consequences of formal and informal education. Science, 182, 553-559.

Shinn, M. (1978). Father absence and children's cognitive development. Psychological Bulletin, 85, 295-324.

Stallings, J. A., & Kaskowitz, D. (1974). Follow-through observation evaluation, 1972-73. Menlo Park, CA: Stanford Research Institute.

Steinkamp, M. W., & Maehr, M. L. (1983). Affect, ability, and science achievement: A quantitative synthesis of correlational research. Review of Educational Research, 3, 369-396.

Stevenson, H. W., Parker, T., Wilkinson, A., Hegion, A., & Fish, E. (1976). Longitudinal study of individual differences in cognitive development and scholastic achievement. Journal of Educational Psychology, 68, 377-400.

Wachs, T. D. (1979). Proximal experience and early cognitive development. Merrill-Palmer Quarterly, 25, 3-41.

Wachs, T. D., & Gruen, G. E. (1982). Early experience and human development. New York: Plenum Press.

Walberg, H. J. (1967). Dimensions of scientific interests in boys and girls studying physics. Science Education, 51, 111-116.

Weikart, D., & Lambie, D. (1968). Preschool intervention through a home teaching program. In J. Hellmuth (Ed.), The disadvantaged child. Seattle: Special Child Publications.

Weitzman, L., & Rizzo, D. (1974). Images of males and females in elementary school textbooks in five subject areas. In Biased textbooks. Washington, DC: National Foundation for the Improvement of Education.

West, P. A. (1933). A study of ability grouping in the elementary school. New York: Teachers College Bureau of Publications.

Wilson, R. S. (1983). The Louisville twin study: Developmental synchronies in behavior. Child Development, 54, 298-316.

Zajonc, R. B. (1976). Family configuration and intelligence. Science, 192, 227-236.

Zajonc, R. B. (1983). Validating the confluence model. Psychological Bulletin, 93, 457-480.

Table 1

Effective Behaviors in Four Stages of Instruction

(Based on Rosenshine & Stevens, 1984)

Stage	Effective Behaviors
Demonstration	1. small steps 2. many examples 3. interspersed questions to check student understanding
Guided Practice	1. frequent questions 2. direct focus on materials 3. continued until a high student success rate is achieved
Feedback/Corrections	1. brief affirmation of a correct response 2. hints, simpler questions, or explanation following an incorrect response
Independent Practice	1. active monitoring 2. sufficient for overlearning and rapid responding

Figure 1

HEURISTIC MODEL

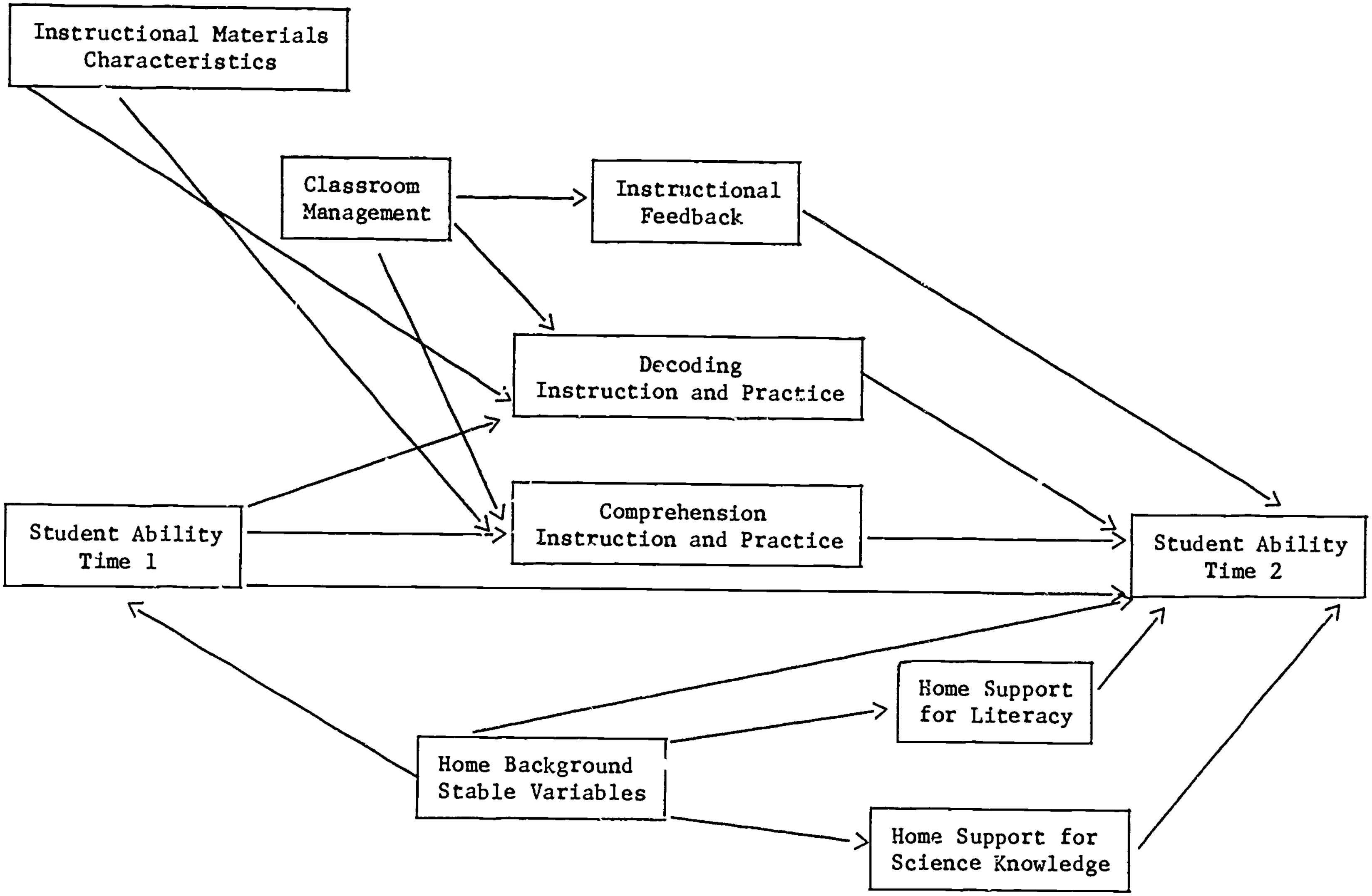

Figure 2

Student Ability Time 1

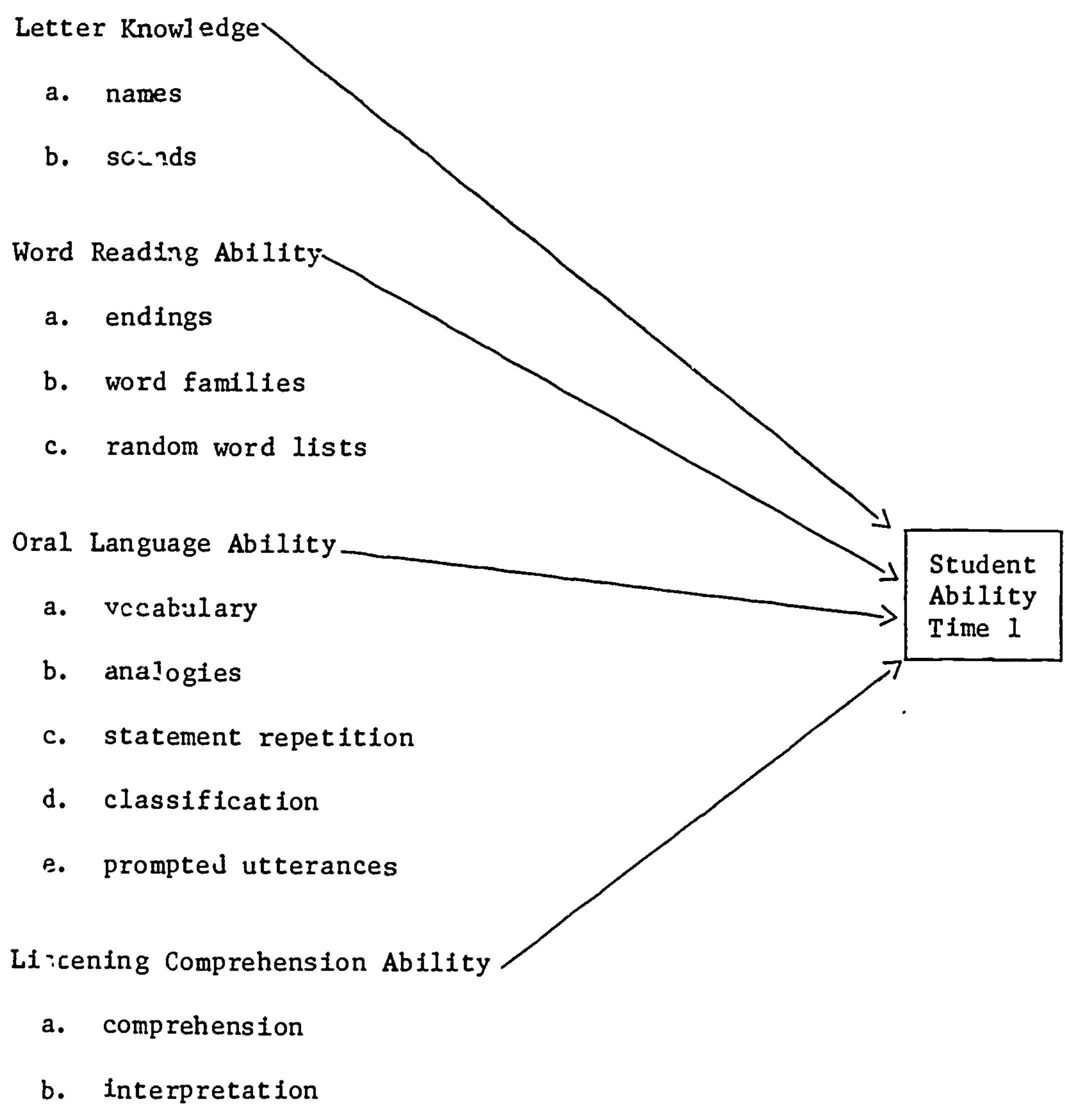

Figure 3

Measurement Model for Materials

Concepts: Basal Reading Programs

- a. letter names
- b. letter sounds
- c. blending
- d. rhyming
- e. whole word reading

Text Characteristics: Reading and Science

- a. vocabulary size
- b. domains taught
- c. text length
- d. text considerateness

Independent Practice Materials

- a. phonics emphasis
- b. text emphasis
  - (1) words in isolation
  - (2) connected text

Comprehension Instruction and Practice: Reading and Science

- a. background knowledge building
- b. text-explicit questions
- c. text-implicit questions
- d. story grammar referents
- e. procedural instructions
- f. practical applications

Assessment: Reading and Science

- a. frequency
- b. ties to phonics instruction
- c. ties to comprehension instruction
- d. ties to vocabulary development
- e. ties to activities

Materials' Characteristics

Figure 4

Measurement Model for Classroom Management

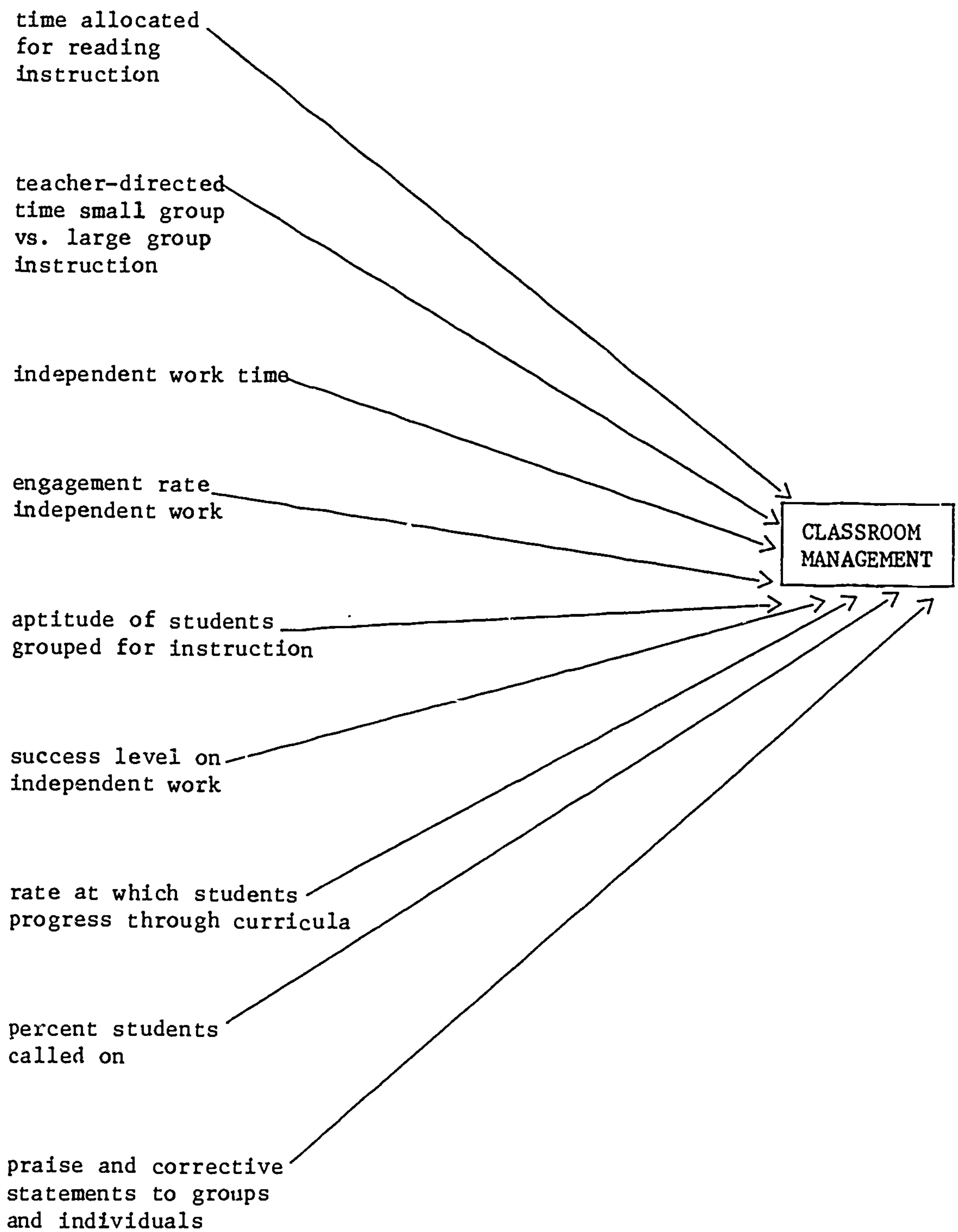

Figure 5

Measurement Model for Feedback

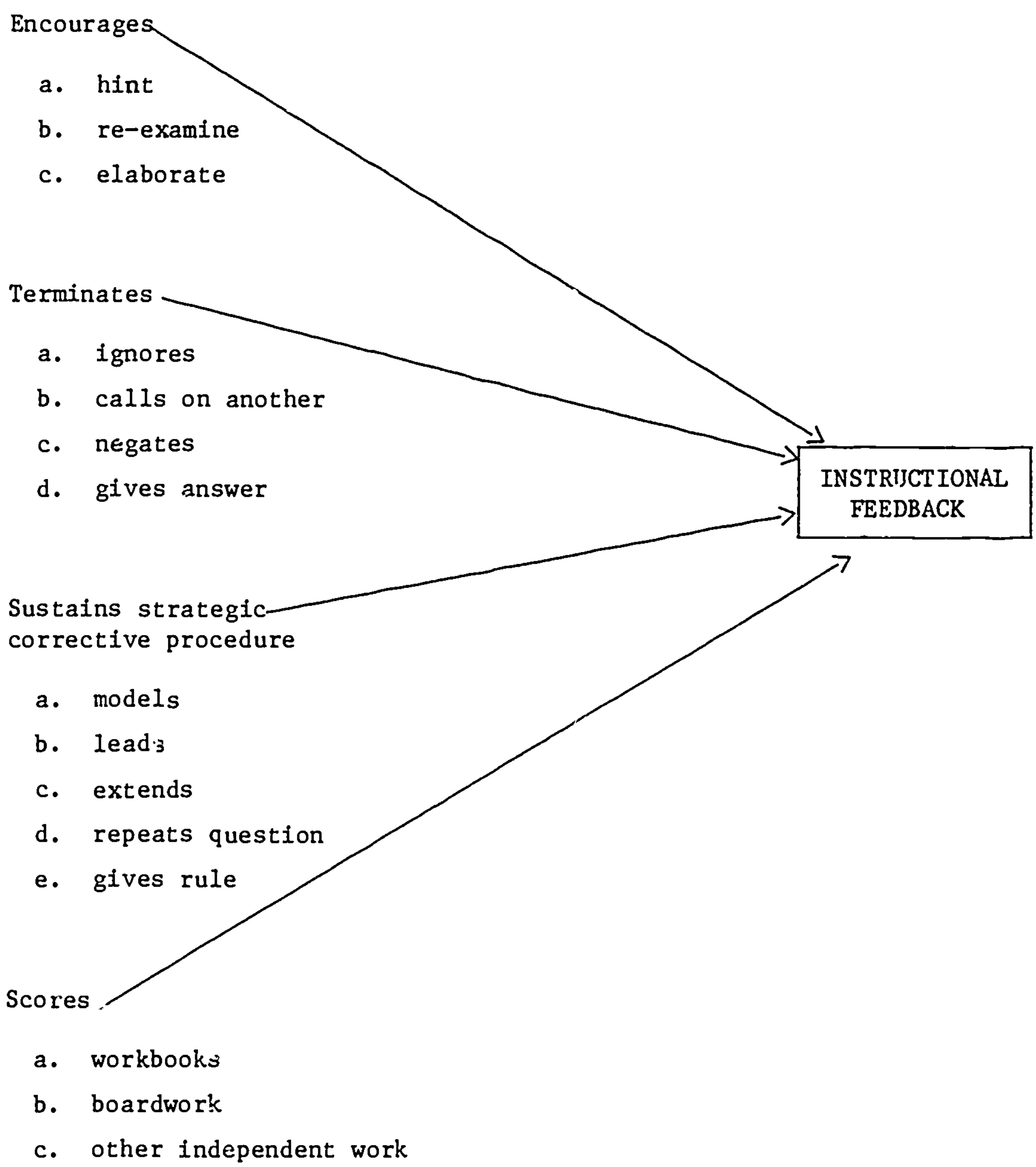

Figure 6

Measurement Model for Decoding Practice

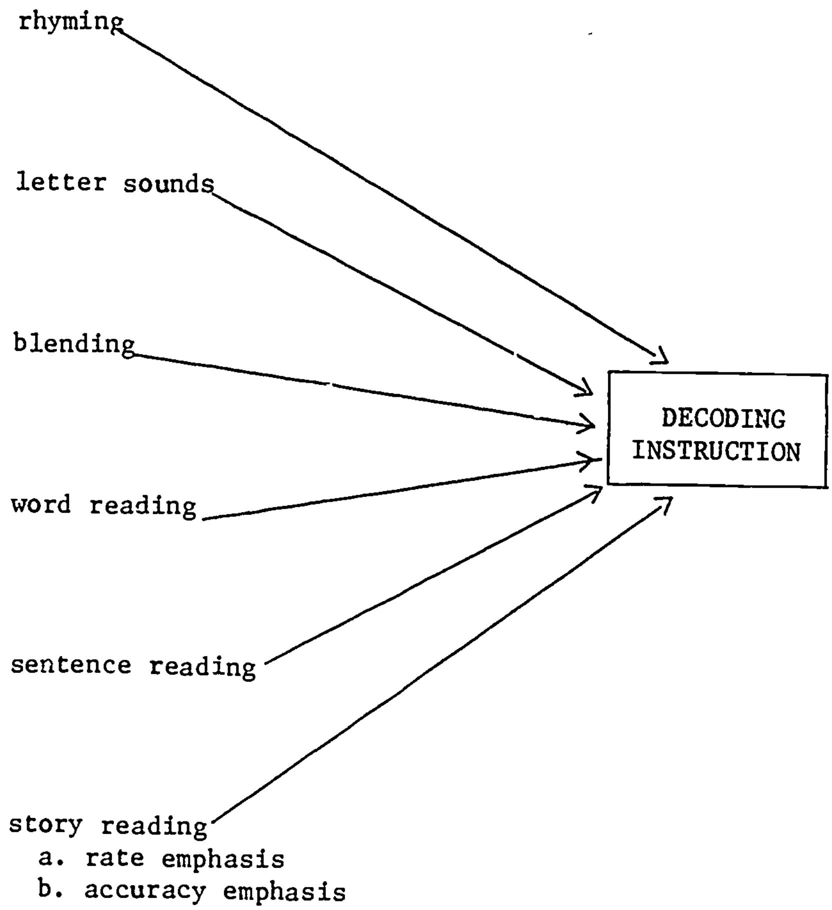

Figure 7

Measurement Model for Comprehending

Narrative and Expository Text

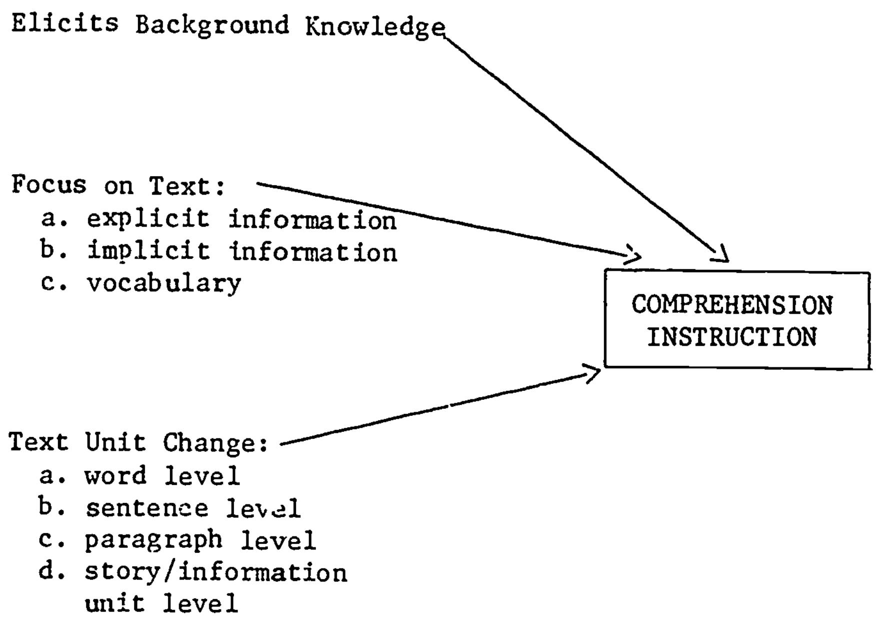

Figure 8

Home Background Stable Variables

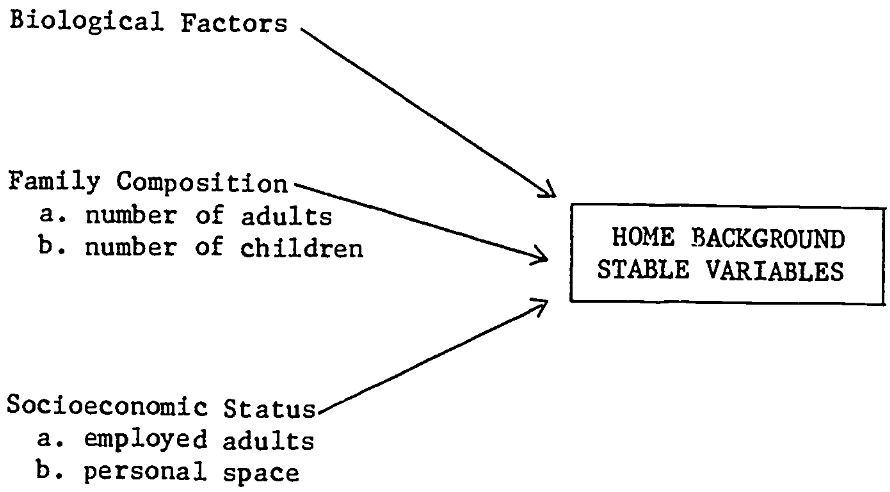

Figure 9

Home Support for Literacy and Science

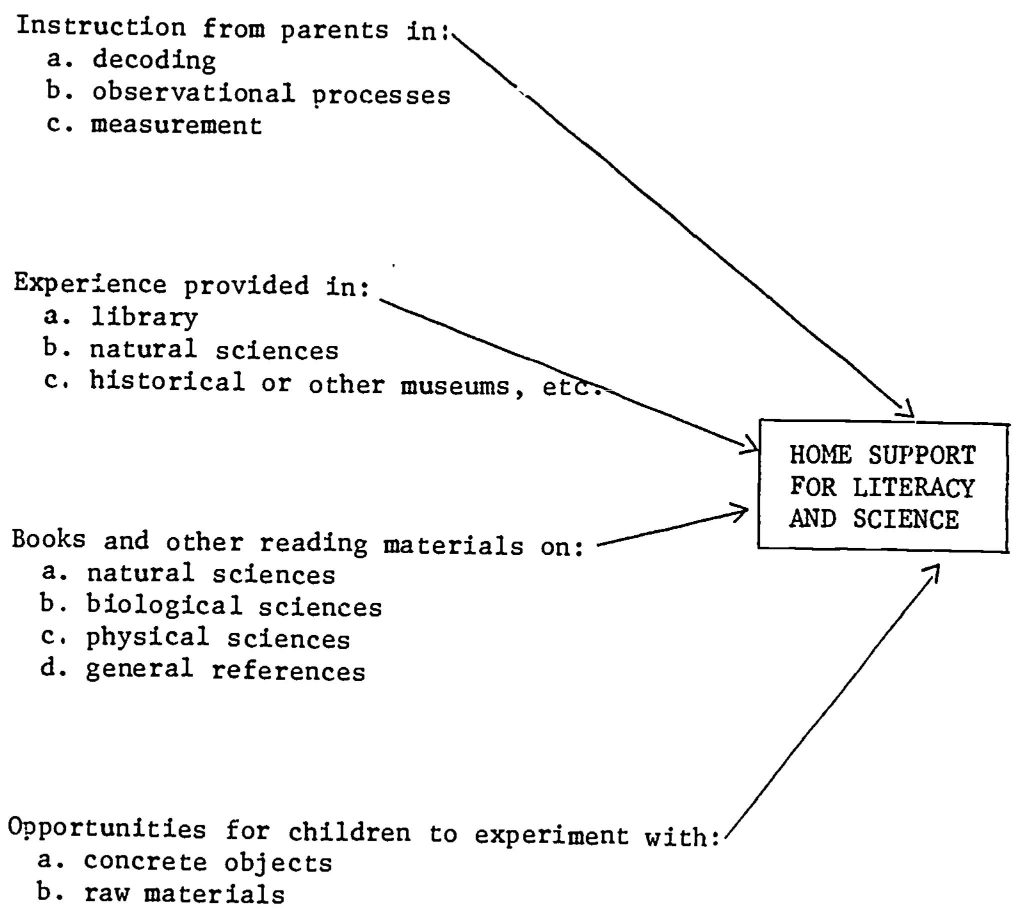

Figure 10

Student Ability Time 2