ACTIVE TEACHING AND ITS INFLUENCE ON STUDENT ACADEMIC ACHIEVEMENT - THE CASE OF GRADE THREE

A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES
ADDIS ABABA UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ARTS IN CURRICULUM AND INSTRUCTION

BY
AHMED REJA

JUNE 2004
ADDIS ABABA

TABLE OF CONTENTS

List of Tables

List of Appendices

Acknowledgements

I am indebted to a number of people who contributed their part during the various stages of the project and my advisor, Dr.Temechegn Engda, was in the lead for his valuable comments and guidance throughout the study. I wish to thank my friend Kifle Gebrekirstos, a graduate student in the Department of Educational Psychology, for his constructive suggestions and unreserved help.

Principals and teachers in the sample primary schools also deserved my thanks for they were most cooperative during the stages of the project.

I would like to mention with appreciation my partner, W/o Lubaba Mohammed, for her assistance and taking care of my family when I was away at the various stages of the study.

Finally, I would like to thank W/o Almaz Teklay for typing the manuscript.

Abstract

The purpose of this study was to examine the influence of active teaching method on grade three mathematics achievement. Active teaching (other terms are also synonymously used throughout the paper), as the process-product research approaches explain, refer to teacher behavior in the classroom. Identified with the teaching model, there are thirty four teacher behaviors categorized in five blocks (see Appendix II). The subjects taken for this study were 15 grade three mathematics teachers randomly selected from 10 primary schools in Mekelle and their students as well. The students (numbering 808) of these teachers were tested at the beginning and end of the training program. The teachers were randomly assigned to three groups: trained teachers observed while implementing the method, trained teachers but unobserved and untrained teachers who simply taught in their style and hence 5 teachers in each group. Both trained groups (the observed and unobserved teachers) were given a 24- page manual on the teaching model and were also trained for five days lasting two hours each. Then, starting the first week of November they continued to instruct in their regular teaching schedules during the study period. Both the trained observed & untrained teachers were observed three times each spaced nearly a month so as to see to what extent the teaching behaviors suggested in the manual were implemented. The trained unobserved group was simply used to see whether the presence of the observer (video recorder) had an effect to the trained observed teachers. The proportions of implementation of the teaching behaviors by both observed groups were computed using percentages and the impact of these teaching behaviors or the influence of the active teaching model on student achievement at the grade level was analyzed using the t-test. The statistical impact on student achievement was accepted as significant at 0.05 α level or better.

Results of the analysis revealed that the proportion of implementation of most of the teaching behaviors was greater in the trained observed teachers than in the untrained teachers. Similarly, posttesting results indicated that students taught by the trained teachers had better mathematics mean scores than students of the untrained teachers and hence could be concluded that active teaching method had an influence on student academic achievement.

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

Curriculum is broadly defined as a plan for the entire educational process. In such planning curriculum works as a continuum of different phases, which include design or development, implementation and, evaluation. Of such phases, as to Tyler (1949:17), it is at the implementation stage that the desired behavioral changes on the part of the learner take place. To achieve this end, among other factors, teachers are particularly responsible and are expected to master a large knowledge base that covers the subject matter they teach, the methods they use to teach it, and the students to whom it is taught.

Although there could be such and other factors that contribute to or determine educational achievement, the selection of appropriate teaching methods and procedures for the intended objective is given due emphasis in current literature. In line with this view, Arends (1997:4) asserted that today's teachers are held accountable for using teaching practices that have been shown to be effective, just as members of other professions are held accountable for best practice in their respective fields.

However, which method for which objective may be the question in the minds of most teachers. Over the years many different approaches to teaching have been created and studied. As (Ibid: 6) pointed out some have been developed by educational researchers investigating the learning process and how particular teaching behaviors affect student performance. Other approaches have been developed by classroom teachers experimenting with their own teaching to solve specific classroom behaviors.

With the availability of a variety of models to teaching, their effectiveness to different instructional goals also varies. That is why educational researchers were, more often than not, saying there is no one best model. A method best serves one purpose may fail for others. Many educationists underscored in their writings the above statements.

> *John Barell and Janet Kierstead demonstrate that one approach is not right and the other wrong; both are right-but for different objectives. No single model of teaching is sufficient to achieve all the aims of schooling (Brandt, 1985:3)*

The use of a particular model allows teachers to achieve some instructional goals, but not others. Direct instruction, for instance, is a good method for helping students learn basic skills such as the multiplication tables or place geography. However, it is not suitable for helping students understand the influence of the earth's topography on agricultural production (Arends, 1997:8).

The point of view that can be taken from the above quoted statements is that no model of instruction is innately better than any other. Hence, classroom teachers need, in Arend's words, a repertoire of teaching practices for instruction in order to meet the diverse instructional goals. The effectiveness of a teaching model underlies what educational researchers call the process-product research. In a process-product research, as Peterson (1979-46) mentioned, researchers try to explore the relationships between teacher behavior as process and student achievement as product of teaching.

Since the effectiveness of a given teaching model could be revealed through the process-product research, this can be most verified through studying teacher behaviors in the classroom. Accordingly, in Ethiopia some studies on the effectiveness of different teaching models have been so far done by graduate students of the Addis Abeba University. However, as to the investigator's knowledge, almost all studies were done on secondary school levels; and no study was made on the effectiveness of a given method to teach primary school subjects.

Consequently, the writer of this paper convinced himself to make a study of teaching grade 3 Mathematics by active teaching approach and its influence on student academic achievement.

1.2. Statement of the Problem

Some people are often heard criticizing direct instruction or as it can also be termed active teaching because of the notion they hold that the approach is teacher-directed. Though it is teacher-directed it does not mean that it should be rejected; because it is most appropriate for some instructional goals.

As Arends (1997:64) put, it is an approach to teaching that helps students learn basic skills and acquire information that can be taught in a step-by-step fashion. He added that:

> *We refer to this approach as the direct instruction model, although it is often referred to by other names, such as active teaching*

(Good & Grouws, 1983), mastery teaching (Hunter, 1982), and explicit instruction (Rosenshine & Stevens, 1986) (Ibid: 64).

With these names the writer used them synonymously throughout the paper. As Rosenshine and Stevens (1986:377) pointed out, active teaching procedures are most applicable in those areas where the objective is to master a body of knowledge or learn a skill which can be taught in a step-by-step manner.

Since mathematics is highly sequential by its nature and the investigator felt that mathematics lessons at the lower primary grades (from his observation of the syllabus and the text) are basic skills, this study was intended to explore the effectiveness of active teaching approach in teaching lower primary mathematics.

The purpose of this study was to examine the effectiveness of active method of teaching mathematics on academic achievement of grade three students. The focus of the teaching program was entirely on instructional behavior.

Hence, to realize this purpose, the following research questions were posed.

1. ***Is there significant difference in implementation of teaching (instructional) behaviors by trained observed and untrained teachers?***
2. ***Does posttesting reveal significant mean difference in Mathematics achievement between students of the trained observed and untrained teachers?***
3. ***Does posttesting reveal significant mean difference in Mathematics achievement between students of the trained unobserved and untrained teachers?***
4. ***Does posttesting reveal significant mean difference in Mathematics achievement between students of the trained observed and trained unobserved teachers?***

1.3. Syntax of the Active Teaching Model

Within the active teaching model, there are specific behaviors which are referred, as instructional behaviors (Good & Grouws, 1979: 355-362), teaching functions (Rosenshine & Stevens, 1986:376), and teaching behaviors (Arends, 1997:67).

Although the detailed or discrete behaviors resemble to one another, the investigator adapted Arend's classification with possible modifications to suit to the Ethiopian situation. A detail of each phase appeared in the training manual that was given for the treatment teachers (see Appendix I)

Phases	Teacher Behavior
1. Provide objectives and establish set	Teacher goes over objectives for the lesson, gives background information, and explains why the lesson is important. Gets students ready to learn.
2. Demonstrate knowledge or skill	Teacher demonstrates the skill correctly or presents step-by-step information.
3. Provide guided practice	Teacher structures initial practice
4. Check understanding and provide feedback	Teacher checks to see if students are performing correctly and provides feedback.

5. Provide extended practice and transfer	Teacher sets conditions for extended practice with attention to transfer to more complex and real life situations.

For observational purposes, the discrete behaviors associated with each of these phases are listed (see Appendix II).

1.4. Significance of the Study

The researcher has two main reasons to select one of the lower primary grades (grade 3) as his focus of the study. First, primary education is undoubtedly the most important of all levels of education. Unless we get it right at the primary level, we cannot hope to improve quality significantly at higher levels. Secondly, as mentioned earlier, no study of teaching method was made at the primary education level.

Apart from these reasons, mathematics in the lower grades highly requires performance skills and teaching of such skills requires selecting the appropriate practices (approaches). However, since most of the teachers at the lower primary are inexperienced or new TTI graduates (from my observation in the region I am working in), they teach without the knowledge of the appropriate teaching methods to the appropriate instructional objectives.

Hence, this study is hoped to contribute in the following ways:

1. the results may inform mathematics syllabus designers and textbook writers about the appropriate teaching model for teaching lower primary mathematics so that they can write lessons and activities accordingly.

2. since the study is expected to indicate relationships among instructional behaviors and students' mathematics achievement, the results may inform teacher training institutes to appraise their programs. Put in other words, once effective instruction is described, then supposedly programs can be designed to promote those effective practices.
3. the results will help lower primary school teachers follow those instructional behaviors which contribute to student achievement.
4. since other teacher variables and their impact on student achievement could comprehensively be studied the study would serve as a supporting document for future research.

1.5. Delimitation of the Study

The study on the influence of the active teaching model on student academic achievement would have been comprehensive had all the lower primary grades been considered. However, because of the nature of the study and subsequent requirements of material and financial resources, it is delimited to only grade 3 Mathematics classes.

1.6. Limitations of the Study

The study was intended to see differences in academic achievement as a result of the discrete teacher behaviors of the active teaching model in which manual and subsequent training were given to the trained teachers. Since the subjects of the project were primary school teachers (grade 3 Mathematics teachers) it was initially difficult to understand the manual by the teachers for it was prepared in English. Nevertheless, the investigator trained the teachers in Tigrigna and hence this additional task contributes to the lengthening of the project.

The results of the study might have to slight extent been affected by the possible communications made by students taught by the different groups of teachers because there was no possibility to control students from communicating.

Financial constraints had also contributions to the relatively few number of observations during the project period.

The other problem, perhaps the major, the writer faced in conducting this study was the absence of recent literature on the subject under discussion. Thus, the writer was obliged to use those old literatures and consequently was not able to relate the findings of this study to current findings if any at all.

1.7. Definition of Terms

The following key terms are frequently used through out the study and defined below. Other terms are defined and explained in detail in the glossary section of the manual that is shown in Appendix I.

Syntax: the overall flow, sequence, or major steps of a particular lesson

Model: is a cluster of strategies which is logically consistent with a certain set of assumptions about how students best learn (Reiman et al, 2002:233)

Active teaching: refers to the small-step approach and is applied to learning hierarchical material because subsequent learning upon well-formed prior learning. It uses the five teaching behaviors included in the teaching model. No single, common term to describe this teaching has emerged as yet. Rather, a variety of terms are being used including direct instruction, systematic teaching, explicit instruction and effective teaching (Rosenshine and Stevens, 1986:378).

Teacher Behavior: Skills, abilities and other attributes of a teacher that students experience directly in the classroom (Murnane and Phillips, 1981:86).

Student Achievement: Student gain scores as the result of process variables (process of teaching or teacher classroom behaviors).

Process-product research: An approach to education research characterized by studying relationships between teacher behavior (process) and student achievement (product)

CHAPTER TWO

REVIEW OF RELATED LITERATURE

In this chapter a review is made on the syntax of the Active Teaching Model with its five phases in which each phase consists of teacher behaviors. Since the study is on Active Mathematics Teaching and Its Effect on Student Achievement, conceptualization of effective teaching, the rationale for the active teaching model and synthesis of research on the various teacher behaviors are included as contents of this chapter.

2.1. Conceptualization of Effective teaching

If teachers, or education officers are asked to define what an effective teacher is some of the responses could obviously be a good person- a role model who meets the community ideal for a good citizen, good parent, and good employee which Borich (1996:2) named the role-model definition. Other responses may attempt to identify a good teacher with personality characteristics (e.g. achievement-motivation, directness and flexibility), attitude (motivation to teach, empathy toward children, and commitment) and experience with a particular grade level) which Ibid (3) named the Psychological Characteristics Definition. It can be understood that though the definitions incorporate traits a good teacher may have, they excluded the most important and obvious measure of all for determining good teaching - the performance of the students who are being taught.

With drawbacks of the above definitions for effective teaching, a new direction emerged. That is, the concept of active (effective) teaching as Jones wrote (1986:9-10) emerges from a strong research base, chiefly from "process-product" research describing the relation between teacher behavior and student performance in particular contexts, from research describing the day-to-day realities of classroom life, and more recently from experimental training studies.

Similarly, looking into a new direction, Borich (1996:6) discussed that teaching is effective when teacher behavior is linked with student performance and continued to say during the 1970s and 1980s researchers developed new methods for studying the interactive patterns of teachers and students in which the goal was to discover which teacher behaviors promote desirable student performance, such as good grades on classroom tests.

The basic tenets of process-product research were also described by Anderson, Evertson and Brophy (1979:14)

> *... to define relationships between what teachers do in the classroom (the process of teaching) and what happens to their students (the products of learning). One product that has received much attention is achievement in the basic skills.*

Effective teachers have different styles and personalities and are considered effective for different reasons. In many communities, teachers are considered effective if many of their students attain some of the following sound academic achievement, an enjoyment of learning, skills to continue to learn, the ability to think creatively, solve problems and contribute to their societies. Effective teachers know their students, their strengths and weaknesses, and give them motivation to excel and remedial assistance when needed. Effective teachers know and respond to the interests of students (Craig et al. 1998, p.12)

Whatever other worthwhile results are achieved because of teachers' work, teacher effectiveness is most commonly expressed in terms of pupils' academic achievement, something that is more easily (and less expensively) measured than some of the other outcomes of good education. Although there are obviously problems in focusing on academic achievement as the sole indicator of teacher effectiveness, the complex of factors that define effective teaching usually contribute strongly to an increase in student academic achievement (according to examinations) in addition to increases in other desired skills and behaviors.

2.2 The Rationale for the Direct Instruction Approach

What is the rationale for the use of direct instruction approach? Some theoretical roots come together and provide the rationale for the direct instruction model. These include, as shown in Arends (1997:68), system analysis, social or behavioral modeling theory, and teacher effectiveness research. Following is a discussion of such roots for the model under discussion.

2.2.1. Systems Analysis

In the area of instruction and learning, systems analysis emphasizes how knowledge and skills are organized and how to systematically break down complex skills and ideas into component parts so that they can be sequentially taught (Ibid). From this it could be understood that systems analysis, which studies how to breakdown the parts of a whole so that they can be taught in small steps, provides one theoretical support for direct instruction.

One of the basic assumptions of direct instruction is to present the lesson in a step-by-step or bit by bit by breaking the whole component into its parts. Put in other words, one of the primary ingredients of the model is presenting material in small steps. As Borich (1996:253) wrote, the content within the lessons must be partitioned and subdivided to organize it into small bits. No portion can be too large; if it is, you will lose your students attention. The key is to focus the material on one idea at a time and to present it so that one point is mastered before the next point is introduced. This is most easily accomplished by dividing a lesson into easily recognizable subparts, rules or categories.

The role of the teacher from the systems analysts point of view is then to structure the lesson in the above form and this helps the students to see the parts of the whole and prepares the student for the subsequent learning. The assumption of the systems analysis is that the student in the instructional process has to consider the different parts to get the understanding about the whole. This is related to the direct instruction approach in which learning step-by-step and breaking the whole into its parts is emphasized. As Arends (1997) argued, complex understandings and skills cannot be entirely learned at anyone time. To learn complex issue they need to be broken into parts.

From the systems analysis theoretical root emerged some instructional functions as indicated earlier. Put in other words. Rosenshine's instructional functions were rooted from the systems analysis.

2.2.2. Behavioral Modeling Theory

Behavioral modeling theory, which studies how people learn from watching others, provides another theoretical support for direct instruction. As Arends (1997:82) argued direct instruction relies heavily on the proposition that much of what is learned comes from observing others. Bandura's behavioral modeling theory specifically demonstrates that it is from watching others model particular behaviors that students learn to perform these same behaviors and to anticipate their consequences.

According to Bandura, cited in Arends (1997:69), behavioral modeling theory is a three-step process involving attention, retention, and production. That is, it depends on the observer's attending to some behavior, then placing his or her perception of the behavior in long-term memory, and finally, retrieving the memory in order to produce the behavior when motivated to do so. As part of the instructional functions, the teacher is expected to provide objectives and gives overviews and giving the rational and overviews for any lesson is important, but particularly so for skill-oriented lessons. Hence, knowing why a particular skill is being taught generally helps to motivate and bring the desired commitment from students. Such idea in the instructional functions approach emanates from the observer's attention which is one of the steps in behavioral modeling theory. Put in other words, behavioral modeling theorists believe that something is learned when the observer consciously attends to some behavior.

As to the view of the behavioral modeling theoretists, students try to observe and imitate what the teacher demonstrates. They learn to perform the behaviors of whom they observe.

From the behavioral modeling theory emanates the second phase (step) of instructional functions i.e. presentation and conducting demonstrations. To effectively demonstrate a particular concept or skill requires teachers to acquire a thorough understanding or mastery of the concept or skills prior to the demonstration and to carefully rehearse all aspects of the demonstration prior to the actual classroom event.

In a discussion of behavioral modeling theoretists, the importance of reinforcement is also mentioned. From their point of view to ensure a positive attitude toward the new skill, the teacher should immediately praise those aspects of the skill that the student performs correctly, then identify any problematic sub skill. As mentioned in Arends (1997:70) Bandura found that the timing and type of feedback provided by the teacher is crucial if practice is to be beneficial. Especially during initial learning, feedback should be immediate, positive, and corrective. All these ideas served as a base or root for the inclusion of guided student practice in which process feedback is emphasized and in correctiveness and feedback as important steps in the direct instruction (active teaching) approach.

2.2.3. Teacher Effectiveness Research

Although the research base for the direct instruction model and its various components comes from many fields, the clearest empirical support for the models effectiveness comes from the teacher effectiveness research (Arends, 1997:71).

As discussed in Ibid, the study by Jane Stallings and her associates illustrated the importance of time on task. This study also contributed empirical support for the use of direct instruction. The

The Direct Instruction Model

Although teachers can adjust their use of direct instruction to fit various situations, this model consists of five essential phases or steps.

1. Provide objectives and establish set
2. Demonstrate knowledge or skill
3. Provide Guided practice
4. Check for understanding and provide feedback
5. Assign independent practice.

2.4. Synthesis of Research on the Various Teacher Behaviors

In this section, research findings on each of the five phases of the direct instruction model are synthesized.

2.4.1. Providing Objectives and Establishing Set

The first step in effective direct instruction lesson is to focus learners' attention. This is done by providing student with a short behavioral objective, such as "Today you will be able to do problems using two- digit multiplication".

The intent of these initial steps is to get students' attention and to motivate them to participate in the lesson. Regardless of the instructional model being used, Arends (1997:79) asserted, good teachers always begin their lessons by explaining their objectives and establishing a learning set.

This is because students need a reason for participating in a particular lesson, and they need to know what is expected of them.

Furthermore, he continued to say effective teachers have found that a brief review which gets students to recall yesterday lesson or perhaps a question that ties in to students' prior knowledge is a good way to get started. These activities also serve as motivators for lesson participation. Each teacher develops his or her own style for establishing set, but no effective teacher eliminates this important element from any lesson. In sum, giving the rationale and overviews for any lesson is important, but particularly so for skill-oriented lessons.

2.4.2. Demonstrating Knowledge or Skill (Presenting new content)

Research has shown that effective teachers of mathematics spend more time on presenting new material than do less effective teachers (Evertson et al. 1980, Good and Grouws 1979). For example, in the Evertson study the most effective Mathematics teachers spent about 23 minutes per day in lecture, demonstration, and discussion in contrast to 11 minutes for the least effective teachers. As indicated in the researchers' findings, the effective teachers used this additional presentation time to give additional explanations and many examples, check for student understanding, and provide sufficient instruction so that the students could practice independently with minimal difficulty. In contrast, the less effective teachers gave much shorter presentations and explanations and then sent the students to independent practice. Under those conditions students were less successful because they were not yet ready for independent practice. Hence, they made too many errors and had to be retaught.

As one component of effective presentation, many researchers emphasized the importance of teacher's clarity. Studies on teacher clarity by Kennedy, Cruickshank and Hafele (1978), and Land and Smith (1979) led to suggestions grouped under four headings: Clarity of goals and main points; step-by-step presentations; specific and concrete procedures; and checking for understanding. Moreover, these studies summarized that it is important for teachers to state the goals of the lesson, provide students with explicit, step- by- step demonstrations of the new material, use many examples, and check to see that all the students understand the material before proceeding to the next point.

Land (1979) described five low-inference variables of teacher clarity which he named: vagueness terms; verbal mazes, specification and emphasis; clear transitions; and unexplained additional content. Hiller and his colleagues (1971) also developed a low inference measure of verb fluency which was indicated by length of sentences; and the use of "uhs" "ahs," and other hesitations. The point to be raised here is what are the effects of all these on student academic achievement? In all the studies located the variable of teacher clarity, significant relationships were found with student achievement.

In a summary of research on low inference variables of teacher clarity, Land (1985) indicated that the frequency of vagueness terms used by the teacher had effects on student achievement. In his review of two process product studies, statistically significant ($P<.05$) or near significant ($P<.07$) negative effects on vagueness were found. In other reviews of process product studies by Denham (1981), three studies found significant effects in favor of clear expositions with clarity accounting for 20%, 8% and 6% of the variance in student achievement.

In a study using a different approach to measuring clarity Hines, Cruickshank, and Kennedy (1982) obtained observer ratings on a cluster of 29 different low-inference variable thought to comprise clarity in teaching. In the college level Mathematics classes studied, variations in clarity were found to account for 52% of the variance in mean class achievement ($P<.03$).

It is observed in the above studies of teacher clarity that the effects of teachers' use of vagueness terms and verbal mazes upon student achievement have been consistently negative. The implications of these findings for the improvement of teaching are, however, in need of research. It is not yet established whether vagueness terms and the elements of verbal mazes are language impediments that can be eliminated through training in verbal expression or whether the problems are rooted in teacher lack of mastery of subject matter, requiring more academic development. The study by Hiller (1971) suggested the later, but there is a need for further study.

2.4.3. Conducting Guided Practice

A major purpose of this activity is to supervise students' initial practice on a skill and provide the active practice. During guided practice, students actively participate by working problems or answering teacher questions. As indicated in a review of research findings by Rosenshine and Stevens (1986: 382-383), results favoring guided practice through teacher questions were obtained by Stallings, Cory, Fairweather and Needles (1977), Stallings, Needles and Stayrook (1979), Soar (1973) and Coker, Lorentz and Coker(1980).

During successful guided practice, two types of questions are usually asked: those calling for specific answers, and process questions, which call for an explanation of how an answer was found. Ibid (1986:383) also indicated that in a correlational study of junior high school mathematics instruction by Evertson, Anderson, Anderson & Brophy (1980a), the most effective teachers asked an average of 24 questions during the 50-minute period, where as the least effective teachers asked only 8.6 questions. The most effective teachers asked 6 process questions per period, where as the least effective teachers asked only 13. In two experimental studies (Anderson et al 1979, Good and Grows 1979), teachers were taught to follow the presentation of new materials with guided practice, using a high frequency of questions; in each study, students in the experimental groups had higher achievement than did students in the control groups.

In all these studies, it is the frequency of practice that is most important. Students need a good deal of practice when learning new material, and effective teachers find ways to provide it. For example, when teaching procedures such as two digit multiplication, the guided practice consists of practicing the skills in small steps with teacher supervision. Some students practice at the board while others work at their seats. When the teacher feels they are ready, the students proceed to the next step. If they are not ready, the teacher gives additional practice.

Two essential components of guided student practice that have effect upon student achievement are teacher questions and student response. Both correlational and experimental studies have shown that a high frequency of teacher directed questions and student answers are important for instruction particularly in basic arithmetic and reading skills in the primary grades. Stallings and Kaskowitz (1974) identified a pattern of "factual question-student response-teacher feed back" as the most functional for student achievement. Similar results favoring guided practice through teacher questions were obtained by Soar (1973), Stallings, Needles and Stayrook (1979) and Coker and Lorentz (1980). The significant correlational results in these studies means that although all teachers asked some questions, the effective teachers asked many while the less effective teachers asked few questions.

Two experimental studies (Anderson et al, 1979; Good and Grouws, 1979) used guided practice as part of the experimental treatment. In each study the teachers who received the additional training were taught to follow the presentation of new material with guided practice. It consisted of questions asked by the teacher and supervised exercises. In both studies, teachers in the trained group asked more questions and had more guided practice than did the control teachers who continued their normal teaching. Also, in both studies, students in the experimental groups had higher achievement than the students of teachers in the control groups.

Similarly, Kulik and Kulic (1979) found that students in college classes which gave weekly quizzes had final examination scores that were higher than the scores of students in classes that had only one or two quizzes during the term. Presumably, the added gain came from the additional practice associated with the weekly quizzes.

The frequency of teacher questions is not the only important factor, because the percentage of correct student responses also plays a role in successful learning. With regard to exactly what the percentage of correct answers should be, Brophy (1980) suggested an 80% success rate when practicing new material and when reviewing the success rate should be very high, perhaps 95% and student responses should be rapid, smooth and confident. In a correlational study of frequent correct responses and student achievement, Anderson et al., (1979) found that the percent of academic interactions where the student gave the correct answer was positively related (r=.49) to achievement gain. Moreover, in his study it was found that the mean percentage of correct answers during reading groups was 73% in the treatment teachers' classrooms but only 66%.in the control classrooms.

In another correlational study of high percentage of correct answers (both during guided practice and independent practice) and achievement gain by Good and Grouws (1977) in fourth grade the more effective math teachers had a success rate of 82% where as the least effective had a success rate of 76%. What can be concluded from the above research results is that a high frequency of correct responses for all students appears to be very important.

In line to a discussion of student responses, it is worth mentioning to consider how teachers provide opportunities for students to answer teacher questions.

A number of studies have provided some information on the issues of organizing and conducting practice. In a correlational study by Brophy and Evertson (1976) and then in an experimental study by Anderson et al. (1979), it was found that in primary grades it was better for student achievement if the teacher called on students in ordered turns. Such ordered turns insure that all students have opportunities to practice and participate, and that they simplify group management by eliminating hand waving and other student attempts to be called on by the teacher (Rosenshine and Stevens, 1986:384).

In another study, however, Anderson and her associates note that although the principle of ordered turns works well in small groups, it would be inappropriate to use this principle with whole class instruction in most situations. They suggest that when a teacher is working with a whole class it is usually more efficient to select certain students to respond to questions or to call on volunteers than to attempt systematic turns (Ibid).

One technique for obtaining a high frequency of responses in a minimum amount of time is through what Becker in Ibid (384) termed choral response. This technique is particularly useful when students are learning materials which need to be over learned such as number facts at the primary grades.

Emphasizing the importance of choral response, Becker argued that choral responding to a signal a) allows the teacher to monitor the learning of all students effectively and quickly; b) allows the teacher to correct the entire group when an error is made, there by diminishing the potential embarrassment of the individual students who make them; and c) makes the drill more like a game because of the whole group participation.

Finally, Rosenshine and Stevens (1986:384) recommended the Oregon Direct Instruction Model which suggests that teachers use a mixture of both choral responses and individual turns during the guided practice phase, with choral responding occurring about 70% of the time.

2.4.4. Checking for Understanding and Providing Feedback

Another major teaching function within the active teaching (direct instruction) model involves responding to student answers and correcting student errors. The teacher so as to check for students understanding normally poses questions. The important point here is how the teacher reacts to student responses whether they are correct or not. Research on instruction has emphasized on the importance of academic feedback- which means informing students about the correctness of their answers. Process-product researches have shown that such feedback is more strongly and consistently related to achievement.

Student responses could vary in nature. Some responses could be correct; some responses partially correct and still others incorrect. So, how should a teacher respond to student answers?

Reactions to correct responses: As to Brophy and Good (1986:364) correct responses should be acknowledged as such, because even if the respondent knows that the answer is correct, some of the onlookers may not. Ordinarily (perhaps 90% of the time) this acknowledgement should take the form of overt feedback, which may range from brief head nods through short affirmation statements ("right," "yes") or repetition of the answer, to more extensive praise or elaboration of the answer.

When a student response is correct, then research suggests that the teacher should simply ask a new question, thereby maintaining the momentum of the practice. There is also value in short statements of acknowledgement (e.g.," right"), which do not disturb the momentum of the lesson. (Rosenshine and Stevens, 1986:385).

Reacting to partly correct responses: The student's response may be incomplete or only partly correct. Following responses that are such nature, teachers ordinarily should affirm the correct part and then follow up by giving clues or rephrasing the question. If this doesn't succeed, the teacher can give the answer or call on another student. (Brophy and Good, 1986:364).

Reacting to incorrect responses. This is the third case in which student response might be incorrect. Following incorrect answers, as to Ibid, teachers should begin by indicating that the response is not correct. Almost all (99 %) of the time, this negative feedback should be simple negation rather than personal criticism. They also forwarded that after indicating that the answer was incorrect, teachers usually should try to elicit an improved response by rephrasing the question or giving clues. Sometimes the feedback following an incorrect answer should include not only the correct answer but a more extended explanation of why the answer is correct. Such extended explanation should be included in the feedback whenever the respondent (or others in the class) might not "get the point" from hearing the answer alone.

According to Rosenshine and Stevens (1986:385), the teacher has two options for remedying this problem either providing the students with prompts or hints to lead them to the correct answer or reteaching the material to the students who do not understand. As to these researchers, both of these approaches to error correction- that is, prompting and reteaching-have been used successfully in experimental research and in effective instructional programs.

Whether one uses hints, prompts, or reteaching the material, Rosenshine and Stevens stressed that errors should not go uncorrected and in most cases if a student makes an error, it is inappropriate to simply give the student the answer and then move on. It is also important that errors be detected and corrected early in a teaching sequence. If early errors are uncorrected they can become extremely difficult to correct later. Rosenshine and Stevens(1986:386).

Once students are firm in giving correct responses, they are taken to the independent practice phase in which they are required to work by their own without teacher guidance and supervision.

2.4.5. Independent Practice

As mentioned above once students are exhibiting some proficiency on the new concepts or skills (as observed in correct responses at least 80% of the time in guided practice), they are ready to begin practicing on their own. The most common context in which independent practice takes place is in individual seatwork. As to the study of Evertson et al.(1980a), students in grades one through seven spend more time working alone on seatwork than on any other activity (approximately 50 to 75% of their time) (Rosenshine and Stevens, 1986:386).

The researchers suggested instructional procedures which can help increase student engagement during seatwork, including:

- The teacher spends more time in demonstration (explanation, discussion) and guided practice
- The teacher makes sure students are ready to work alone, by achieving a correct response rate of 80% or higher during guided practice
- The seatwork activity follows directly after guided practice
- The seatwork exercises are directly relevant to the demonstration and guided practice activities.
- The teacher guides the students through the first few seatwork problems (Ibid)

There is ample support for these instructional procedures in research. The following are some of the findings incorporated in the review of Rosenshine and Stevens (1986: 386-387).

Evertson found that the most effective teachers spent 24 minutes (in a 50-minute period) in demonstration and guided practice, where as the least effective teachers spent only 10 minutes on these same activities. Similarly, Fisher et al. (1978), as cited in Rosenshine and Stevens (1986:387), found that teachers who had more questions and answers during group work had more engagement during seatwork. That is, another way to increase engagement during seatwork is to have more teacher-led practice during group work so that the students can be more successful during seatwork.

Another finding by Fisher et al. (1978), as quoted by Ibid, was that when teachers had to give a good deal of explanation during seatwork, student error rates were higher. Having to re-explain to many students during seatwork suggests that the initial explanation was not sufficient or that here was not sufficient practice and corrections before seatwork began. The students were not adequately prepared to work on their own. Ibid also mentioned that in another study by Evertson et al. (1980b) there was a finding that long contacts during seatwork were negatively related to achievement and regarding how long should these contacts be the research suggests that they should be relatively short, averaging 30 seconds or less. According to the researcher, longer contacts appear to pose two difficulties: a) the need for a long contact suggests that the initial explanation was not clearly understood, and: b) the more time a teacher spends with one student, the less time there is to monitor and help other students.

In addition to the instructional procedures a teacher should follow during seatwork or independent practice, some useful management procedures were also suggested by Rosenshine and Stevens.

- The teacher circulates among the students during seatwork, providing feedback, asking questions, and giving short explanations.
- When the teacher is instructing a small group and the rest of the class is working on seatwork, the teacher arranges the seats so s/he can face both the small group and the students working in dependently. Rosenshine and Stevens(1986:387)

In summary, although seatwork activities take place in all classrooms, the successful teachers as to the above findings spend a good deal more time than do average teachers in demonstrating what is being taught and in leading the students in guided practice. Students who are adequately prepared during the teacher-led activities are then more able to succeed during the seatwork. Therefore, successful independent practice requires both adequate preparation of the students, and effective teacher management of the activity.

CHAPTER THREE

METHOD OF THE STUDY

The main purpose of this descriptive study was to investigate the extent to which teacher classroom behaviors influence Mathematics achievement of third graders in Mekelle Town. Accordingly, this chapter describes the research variables, the sampling procedures followed, the instruments of data collection employed, and the methods of data analysis used.

3.1. The Research Variables

In this study the researcher examined the impact of active teaching method on student mathematics achievement. Hence, the variable used as a criterion measure was student score on Mathematics achievement test that was prepared by subject experts.

The independent variable was the active teaching method in which teacher classroom behaviors identified with the method were described in five major blocks (Arend's classification). These teacher behaviors were selected after the investigator made an extensive survey of related literature reflecting the works of process-product researchers. The study described whether the method under discussion influences student achievement or not.

3.2. Subjects and Sampling Procedures

The subjects were grade three Mathematics students in Mekelle town since the extent to which the teaching method influences could be revealed in their achievement.This town was selected as the center of the study for a number of reasons. First, there are enough number of primary schools within the town as compared to all areas that are nearer to the investigator's working place so that it would help to have adequate sample. Secondly, the investigator could secure adequate cooperation and assistance from directors and teachers with some of whom he had personal acquaintance. Thirdly, there were people, with M.A. in Curriculum and Instruction and with enough background of the teaching model, whom I thought could assist me in coding the instructional behaviors of the observed teachers. There are about 17 governmental primary schools within the town out of which 10 schools with at least three sections in the grade level were purposely selected. There were a total of fifteen grade three mathematics teachers in the ten selected primary schools (one school with three teachers, three schools with two and six schools with one). These teachers were randomly assigned to three groups: trained observed, trained but unobserved and untrained teachers. The inclusion of trained but unobserved group was simply to see whether the presence of the observer (video recorder) had an influence on teachers classroom behavior and hence on student achievement. The investigator considered only those government primary schools for he believed that they operate in similar contexts (for instance, in the non governmental schools teachers teach the same grade level in a double-shift system). There were a total of 818 students (262, 284 and 272) who were taught by the trained observed teachers, trained but unobserved teachers and untrained teachers respectively. All of them took the pretest but ten pupils (three, four and three from each of the above groups respectively) did not appear for the posttest. Therefore, they were excluded from the analysis.

3.3. Instruments of Data Collection

The relevant data for the study were collected using two instruments.

1. Pretest-posttest (Mathematics achievement test) and
2. Classroom teachers' observation checklist.

3.3.1. Achievement Test

A pretest on Mathematics content which the students were not exposed to was prepared by subject teachers with many years of experience in teaching the subject (these teachers were not in the target groups of the study). The test was given to experts in the Mathematics Panel of the Regional Curriculum Department to check whether it was prepared in line with the objectives. They approved that except for three items all the test items were developed based on the grade level objectives given in the Mathematics Syllabus for Grades 1-4 prepared by the ICDR (1994 E.C.) and the content covered in the textbook. With the exclusion of those three items, the test originally consisted of twenty five items and was pilot tested with students who didn't participate in the study. All the three sections (numbering 162 students) of the Merha Tibeb Complete Primary School which was not part of the study were used for pilot testing. After the items were pilot tested they were analyzed in order to identify the discrimination power of each item.

To determine the quality of the test, discrimination index of items was calculated according the steps suggested by Ebel (1979:258). Accordingly, five items were rejected for they negatively discriminated between the upper group and the lower group (i.e more number of students from the lower group scored the items right than from the upper group). All the other items were accepted as parts of the pretest given to all students of the teachers under study. These students were pretested in October 25, 2003

After the training and implementation of the instructional behaviors, a posttest was administered to all students taught by the three groups of teachers in March 22, 2004. The pretest and posttest were of the same type. To see whether the active teaching model had an influence on student achievement or not, mean gain scores were computed for students using their pretest and posttest scores on Mathematics achievement test (the students' pretest score was used as a covariate).

3.3.2. Classroom Observation Checklist

The trained teachers were given the manual on the teaching model along with the instructions to read it and to begin to plan for implementation.

The manual contained a system of sequential steps for teaching Mathematics. The teachers were told to read the manual and had five two hour training sessions and all the training sessions were conducted in Tigrigna so as to help them understand and proceed to implement the key instructional behaviors of the active teaching model in their teaching of Mathematics.

After the training given, all teachers continued to instruct in their regular teaching periods. i.e the trained teachers as per the training given to them and the untrained teachers in their own style. During their teaching (implementation) period, which was nearly sixteen weeks, the trained observed and untrained teachers were observed and videotaped three times so as to see to what extent teaching behaviors of the active teaching model were implemented.

3.4. Method of Data Analysis

As described in 3.1, the instructional behaviors included in the checklist were prepared based on literature review. Before classroom observation started the three coders (two with M.A in Curriculum and Instruction and with enough background of the teaching model and the investigator himself) had a thorough discussion on the items (the specific instructional behaviors) degree of relevance to each phase (block) of the model in Appendix II. Finally, the items which the coders agreed as relevant were included in the checklist. Moreover, they also agreed on coding procedures of the implementation of the instructional behaviors by the trained observed and untrained group of teachers. In other words, they detailed what specific behaviors constitute a given instructional behavior.

From the videotapes of the observed teachers, the coders coded whether each of the instructional behavior of the active teaching model in the checklist was implemented or not. Then, proportions of implementation of those teacher instructional behaviors were computed for the observed teachers by the three coders. To indicate proportions, percentages and means were used. Moreover, to see whether these instructional behaviors or active teaching as a model had an influence on student achievement, posttest mean comparisons of students taught by the different groups were made.

In all cases, the statistical technique of t-test was employed as the basic method of data analysis. The statistical impact on student achievement was then accepted at 0.05 (or better) significant level.

CHAPTER FOUR

DATA PRESENTATION AND DISCUSSION

The purpose of this study was to examine active mathematics teaching and its influence on student academic achievement. The focus of the teaching program was entirely on instructional (teaching) behavior.

Hence, prior to looking into the scores of students on the posttest which was administered at the end of the training program, the proportion of implementation of teaching (instructional) behaviors by trained observed and untrained teachers is presented so as to see whether there was significance difference between the groups.

4.1. The Proportion of Implementation of Teaching Behaviors

Before looking into the influence of active teaching on student achievement, it is important to see to what extent the instructional behaviors of the model were implemented by the observed teachers. Because this tends to give an answer for the research question "is there significance difference in the proportion of implementation of instructional behaviors by trained observed and untrained teachers?" posed in chapter 1. The difference was analyzed using the t-test and all data relevant to the analysis are presented in the following table.

Table 1: Proportion of implementation of teaching (instructional) behaviors and their t-values for the trained observed and untrained teachers.

Item No.	Trained Observed Teachers			Untrained Teachers			t-Value
	%	X	S.D	%	X	S.D	
1.1	84.44	7.60	1.140	48.89	4.40	1.140	4.4383*
1.2	82.22	7.40	1.140	26.67	2.40	1.673	5.5226*
1.3	71.11	6.40	1.140	20.00	1.80	1.304	5.9386 *
1.4	64.44	5.80	0.837	15.56	1.40	1.140	6.9567*
2.1	73.33	6.60	0.894	17.78	1.60	1.140	7.7173*
2.2	77.78	7.00	1.581	68.89	6.20	1.643	0.7845
2.3	66.67	6.00	2.000	68.89	6.20	1.483	-0.1796
2.4	62.22	5.60	2.074	13.33	1.20	1.304	4.0160*
2.5	73.33	6.60	1.140	73.33	6.60	1.517	0.0000
2.6	13.33	1.20	1.304	68.89	6.20	1.304	-6.0626*
2.7	62.22	5.60	1.140	15.56	1.40	1.140	5.8252*
2.8	73.33	6.60	1.140	35.56	3.20	1.304	4.3894*
2.9	55.56	5.00	1.581	24.44	2.20	1.304	3.0551*
2.10	46.67	4.20	1.924	24.44	2.20	1.304	1.9240
2.11	62.22	5.60	1.140	40.00	3.60	2.074	1.8896
2.12	31.11	2.80	1.304	15.56	1.40	1.140	1.8074
2.13	11.11	1.00	1.225	33.33	3.00	1.000	-2.8281*
2.14	8.89	0.80	0.837	17.78	1.60	0.894	-1.4607
2.15	66.67	6.00	1.581	13.33	1.20	1.304	5.2372*
3.1	68.89	6.20	1.304	31.11	2.80	1.643	3.6245*
3.2	82.22	7.40	1.140	55.56	5.00	0.707	4.0006*
3.3	82.22	7.40	0.894	60.00	5.40	1.673	2.3576*
3.4	42.22	3.80	1.304	15.56	1.40	1.140	3.0984*
3.5	75.56	6.80	1.304	17.78	1.60	1.140	6.7132*
4.1	80.00	7.20	0.837	26.67	2.40	1.140	7.5891*
4.2	77.78	7.00	2.345	37.78	3.40	1.140	3.0873*
4.3	73.33	6.60	0.548	26.67	2.40	1.342	6.4788*
4.4	40.00	3.60	1.342	17.78	1.60	0.548	3.0851*
4.5	20.00	1.80	0.837	15.56	1.40	1.140	0.6321
4.5	80.00	7.20	1.304	40.00	3.60	1.140	4.6476*
5.1	75.56	6.80	1.304	17.78	1.60	1.211	6.5338*
5.2	75.56	6.80	1.095	26.67	2.40	1.517	5.2588*
5.3	71.11	6.40	2.074	20.00	1.80	1.643	3.8875*
5.4	11.11	1.00	0.707	17.78	1.60	0.894	-1.1771

*P<.05

To see whether there is significance difference or not in the proportion of implementation of teaching behaviors by the trained and untrained teachers, reference is made to the above table that consists of those behaviors included on the checklist (see Appendix II).

For instance, let's consider the first raw with the item number 1.1 of the instructional (teaching) behavior stated in the checklist as "did the teacher go over objectives for the lesson?" In 84.44% of the observations, trained teachers were found to state objectives for the lesson, where as untrained teachers were found to state objectives 48.89% of the observation time. In this case, the implementation of this particular teaching behavior (1.1) by the trained teachers was much greater than by the untrained teachers. However, this difference in percentage does not indicate whether the difference is significant or not. Therefore, a t-test was used and the t-value (4.4383) revealed that there was a statistically significant difference between the trained and untrained teachers in favor of the former group for the calculated t value is greater than the critical value of t=2.306. Similarly, all items, in the first block (1.1-1.4) had observed t-values greater than the critical t value. Therefore, for these particular teaching behaviors of the first block, the trained teachers performed significantly higher than the untrained teachers.

An interpretation could be advanced at this point. Since all items of the first block are intended to get students' attention and to motivate them to participate in the lesson, Arends (1997:79) asserted that good teachers always begin their lessons by explaining their objectives regardless of the instructional model being used. The finding of this study pertaining to the first phase of the teaching model is in line with what is suggested above.

Based on the analysis and interpretation of data discussed above, generalizations can be made about the 34 teaching behaviors listed in table 1, under five blocks. The trained teachers did not differ significantly from the untrained teachers in the following 9 teaching behaviors: 2.2, 2.3, 2.5, 2.10, 2.11, 2.12, 2.14, 4.5 and 5.4 (see Appendix II). That means, these behaviors did not indicate t- values greater than 2.306.

It is in order to advance some seasons why the trained and the untrained teachers did not significantly differ in implementing the 9 instructional behaviors. For instance when we considered items 2.2 and 2.3, which stated as "Did the teacher provide illustrations and concrete examples?" "Did the teacher use demonstration and model during presentation?" respectively, two possible reasons could be forwarded a) Since teachers are required to comply with the school calendar to cover lessons, both groups might have been reluctant to go through these teaching behaviors in their lessons. b) The short period of training time may not be sufficient for the trained teachers to master the skills necessary for implementing these behaviors.

Regarding item number 2.5, which reads as "Did the teacher use clear language?" no difference was observed between the trained and the untrained teachers. Since clarity, as it appears in literature, refers to the teacher's ability to avoid vagueness terms, verbal mazes etc both groups didn't show significance difference. This could be because of the simplicity of the language since the medium of instruction at the primary grades is in local language. At this point, clarity studies by Rosenshine (1968) and Hiller et al. (1969) in Brophy and Good (1986:355) also indicated that language impediments contribute to lack of teacher's clarity.

4.2. Population Means of Student Achievement

As indicated in chapter 1, research questions were posed with regard to whether posttesting reveals significance mean difference in mathematics achievement among students taught by the different groups of teachers because of the influence of the active teaching method. Prior to this, it is quite important to see the students' mean scores in their pretest results before the teachers started to implement the teaching method. The following table summarizes the data.

Table 2: Comparison of means in the pretest results of students in the three groups

Groups	N	X	S	t	P
STOT	259	9.63	1.5780	0.529	0.598
SUT	269	9.55	1.8554		
STUT	280	9.60	1.5323	0.735	0.461
SUT	269	9.55	1.8554		
STUT	280	9.60	1.5323	0.207	0.836
STOT	259	9.63	1.5780		

STOT - Students of the trained observed teachers
SUT - Students of the untrained teachers
STUT - Students of the trained but unobserved teachers

As can be seen in Table 2, the t-test revealed that there is no significant difference in academic achievement between students of the trained teachers and the untrained teachers as shown in their pretest scores. This means that the students had similar achievement scores and there was no significant mean difference for t- observed values in all cases are less than the t-critical = 1.96

So as to provide answers for the research questions 2 - 4 stated in chapter 1 i.e whether posttesting results reveal significant mean difference among students of the different groups of teachers, pairings of groups were made and t-test was employed with the level of significance established at .05. The data is presented in Table 3.

Table 3: Comparison of means in the posttest results of students in the different groups

Pair	Group	N	X	S	t	P
1	STOT	259	13.24	1.9555		
	STU	269	11.13	1.7411	13.049	.000*
2	STUT	280	13.30	2.0962		
	STU	269	11.13	1.7411	13.171	.000*
3	STUT	280	13.30	2.0962		
	STOT	259	13.24	1.9555	0.329	.743

* P<.05

Based on the data in the above table, the following comparisons are made and described accordingly.

A) Students of the trained observed and the untrained teachers

Since the observed t-value (13.049) exceeds the critical value (t_{cr} =1.96), a statistically significant mean difference is observed between posttest results of students of both groups. This means that students of the trained observed teachers had greater academic achievement than students of the untrained teachers and this can be attributed to the influence of the teaching method that was implemented by the trained teachers.

B) Students of the trained but unobserved and the untrained teachers

In both groups, likewise, a statistically significant mean difference is observed for the calculated t-value (t_o=13.171) exceeds the critical t-value (t_{cr}= 1.96). Similarly, though the trained teachers were not observed, their students had greater academic achievement than students of the untrained teachers and this difference could be attributed to the influence of the teaching method which the teachers were trained for.

C) Students of the trained observed and the trained but unobserved teachers

Between these groups, no significant mean difference was observed for the observed t-value (t_o=0.329) is less than the critical t-value (t_{cr}= 1.96). This means that both groups of trained teachers implemented the instructional behaviors as a result of the training they had and their students did not significantly differ in their academic achievement.

Hence, the differences observed on student academic achievement in all cases could be attributed to the influence of the teaching method under discussion.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND ECOMMENDATIONS

5.1. Summary

The purpose of this study was to examine the influence of a mathematics teaching program (namely active teaching) on student achievement with the program focusing entirely on instructional (teaching) behavior. To realize this purpose, 15 teachers drawn from 10 primary schools in Mekelle were randomly assigned to three groups-trained observed, trained but unobserved, and untrained teachers. The trained groups (both the observed and the unobserved) were given a manual on the method and also trained on how to implement the instructional behaviors suggested in the manual. Then after, they continued to teach in their regular teaching periods. The untrained group teachers didn't get the training and were told to teach in their own style. Both the trained observed and the untrained teachers were observed and videotaped three times during the study period. One of the trained groups of teachers was not totally observed for the group was used simply to avoid the effect of the presence of the observer. The proportion of implementation of the various teaching behaviors of both observed groups was coded by three coders and from the coding process percentages and means are calculated.

In order to see whether there was significance difference between both groups, a t-test was employed. At the end of the project, a posttest was administered to 808 students of the untrained, trained observed and trained but unobserved teachers (259, 269 and 280 respectively). Mean comparisons of the posttest were made and analyzed for their significance difference using the t-test at 0.05 level of significance. Accordingly, the research questions presented in chapter 1 were answered and findings are summarized in the following:

1. The first research question was that "is there significance difference in the proportion of implementation of teaching behaviors by the trained observed and the untrained teachers". As seen from the implementation data in Table 1, the trained teachers were significantly different from the untrained teachers in that they implemented most of the instructional behaviors of the active teaching model better than the untrained teachers did.

2. A statistically significant mean difference in academic achievement between students of the trained teachers (both observed and unobserved) and students of the untrained teachers was found. This means that students of the trained teachers were better in achievement than students of the untrained teachers. The difference in such an achievement could be attributed to the influence of the active teaching method which the teachers were trained with.

3. Students of the trained observed and students of the trained but unobserved teachers did not show significance mean difference in their posttest results. For both group of teachers did get the training, their students did not differ in achievement.

5.2. Conclusions

With the short period of the project and a relatively few number of observations per teacher, this study yielded important results and on the basis of these results, the following conclusions are drawn.

1. In all the classroom observations, the trained teachers were found better in starting their lessons with stating objectives and getting their students ready to learn. In a review of numerous studies of mathematics instruction, Rosenshine and Stevens (1986:382) reported that the most effective teachers state the goals of the lesson more than the least effective teachers do and the finding of this study also strengthens their report.

2. Although demonstration is one major part of instruction in mathematics, no significant difference was observed between the observed groups. All teachers, of course, demonstrate new skills, but researches in grade four to eight have shown that effective mathematics teachers spend more time in demonstration than do less effective teachers (Evertson, et al, Good & Grouws, Stallings, Needles cited in Wittrock, 1986:381). For such inconsistency of these findings pertaining to this particular teaching behavior, the reason for the low level of implementation of this behavior may be due to teachers focusing on the many other teaching requests that were perhaps easier to implement. Alternatively, teachers might not have had the knowledge base necessary to focus on demonstration for relatively long periods of time. However, the trained teachers were found better in teaching the subject in small steps as compared to the untrained teachers and studies by Good and Grouws cited in Wittrock (1986:376) indicated that teachers'

step-by-step presentation leads to increased achievement and student engagement in their classrooms.

3. In all the instructional behaviors associated with guided practice, the trained teachers spent more time asking questions, correcting errors, and giving opportunity for students to practice and were significantly different from the untrained teachers. This finding is in agreement with Wittrock (1986:382).

4. Another phase of the active teaching model is "checking for understanding". In many of the instructional behaviors in this category, the trained teachers were significantly different in that they frequently assessed whether the students understand the content or skill being taught, or steps in a process. This is also in agreement with the findings reviewed by Rosenshine and Stevens (1986, 378-386).

From this study it can be generally concluded that the higher the teachers are trained for the specific instructional procedures of the teaching method, the higher the influence of the method on the academic achievement of their students. However, this study is not suggesting that the instructional program used in the study is the only or best approach to take for facilitating the mathematics achievement of students. Rather, it explains that the active teaching instructional program appears to have considerable value for teachers in teaching mathematics in the primary grades.

5.3. Recommendations

Any improvement in a given method calls for educators and/or researchers concern who strive for the betterment of the teaching learning process and recommendations are geared towards this. In light of the analysis and conclusions drawn, the following recommendations are given.

1. Textbook writers should be well informed of the active teaching model so that primary mathematics textbooks could be written to promote all the instructional behaviors on the part of the subject teacher.

2. Institutions for primary school teachers training should emphasize this active teaching program, which enables teachers to teach subjects that are well structured and can be taught step-by –step like mathematics in the primary grades.

3. Mathematics teachers at the primary grade levels should devise their own strategies to implement the instructional behaviors in accordance with the period allotment and the school academic calendar.

REFERENCES

Alan, Reiman, Sandra De Angelis Peace, and Lois Sprinthall, (2002) **SUCCEED at Instruction. A Resource for Beginning Educators and Instructional Leaders.** NC State University, College of Education.

Anderson, L. (1979) "Achievement-related Differences in Students' Responses to Seatwork" **The Elementary School Journal.**, Vol. 76

Anderson, L., Evertson, C., & Brophy, J. (1980) "The First Grade Reading Group Study: Experimental and Process-outcome Relationships." **Review of Research in Education.**, Vol. 8

Arends, R (1997). **Classroom Instruction and Management.** New York: Mc Graw-Hill Companies, Inc.

Berliner, David C. (1976) "Impediments to the study of Teacher Effectiveness." **Journal of Teacher Education** Vol. 32(1)

Billstein, Rick, Shlomo, & Johnny W. Lott (1998). **A Problem Solving Approach to Mathematics.** Addison-Wesley Longman, Inc.

Borich, G.D. (1996) **Effective Teaching Methods** (3^{rd} Ed). Prentice-Hall, Inc. Englewood Cliffs, New Jersey 7632

Brandt, R (1985). "Toward a Better Definition of Teaching." **Educational Leadership** Vol.42 (8)

Brophy, Jere E. (1979). "Teacher Behavior and Its Effects". **Journal of Educational Psychology**, Vol.71

Brophy, Jere and T.L. Good (1986) "Teacher Behavior and Its Achievement." in Marlin C. Wittrook (ed.) **Hand Book of Research on Teaching** (3rd Ed.) New York: Macmillan. Inc.

Coker, H., & Soar, R. (1980) "How Valid are Expert Opinions about Effective Teaching" **Journal of Teacher Education**, Vol. 17

Craig, Helen, Richard Kraft and Joy duPlessis (1998). **Teacher development: Making an Impact**, Washington, DC: USAID, World Bank.

Ebel, Robert L. (1979) **Essentials of Educational Measurement** (3rd Ed.). New Jersy: Prentice-Hall Inc.

Good, T. L. (1979) "Teacher Effectiveness in Elementary School." **Journal of Teacher Education**, Vol.30 No. 2

Good, T. and D. Grouws. (1979) "The Missouri Mathematics Effectiveness Project: An Experimental Study in Fourth Grade Classrooms." **Journal of Educational Psychology**, Vol.79 (2)

Hiller, J. H. (1971) "Verbal Response Indicators of Conceptual Vagueness" **America Educational Research Journal**, Vol. 8

Hines, C. V., Cruickshank, D. R., & Kennedy, J. J. (1982) "Measures of Teacher Clarity and Their Relationships to Student Achievement and Satisfaction" **The Elementary School Journal,** Vol. 80

ICDR (2002) **Mathematics Syllabus for Grades 1-4** Addis Ababa

Kierstead, Janet. (1985) "Direct Instruction and Experimental Approach: Are They Really Mutually Exclusive?" **Educational Leadership**. Vo1.42(8).

Kulic, J. A., & Kulik, C. L. (1979) "College Teaching" in P. L. Peterson (Ed.). **Research on Teaching.**

Land, M. L. (1979) "Low-Inference Variables of Teacher Clarity: Effects on Student Concept Learning." **Journal of Educational Psychology**, Vol. 71, No. 6

Land, M. L. and Lyle R. Smith (1979) "Effect of a Teacher Clarity Variable on Student Achievement." **Journal of Educational Research**, Vol.72, No. 4

Peterson. P.L. (1979). "Direct Instruction for What and for Whom?" **Educational Leadership** Vol.37 (1)

Rosenshine, B. (1983) "Teaching Functions in Instructional Programs." **The Elementary School Journal.**, Vol. 83, No.4

Rosenshine, B (1986) "Synthesis of Research on Explicit Teaching." **Educational Leadership,** Vol. 43. No. 2

Rosenshine, Barak and Robert Stevens (1986)." Teaching Functions" in M.C Wittrock (Ed) **Hand Book of Research on Teaching** (3rd Ed.) New York: Macmillan. Inc.

Temechegn Engda (2001) **A course material on Issues, Methods and Materials in Teaching Primary School Subjects**, Faculty of Education, AAU

Tyler, R.W (1949) **Basic Principles of Curriculum and Instruction**. Chicago: Chicago University Press

APPENDIX I

Manual of the Active Teaching Model with Techniques to Implement the Five Instructional Phases by Grade Three Experimental Mathematics Teachers.

Table of contents

Introduction

The experimental research to be carried out is on "Active Mathematics Teaching and its effect on Student Academic Achievement - An Experimental Study of Grade Three". In this research project you will be the experimental grade three mathematics teachers who are expected to implement the five instructional phases in your classrooms. In order to have a clear understanding of the phases and techniques, you will be given enough training on the teaching model supplemented by this manual which will be at your hand.

This manual has four parts. It begins with the five instructional phases and the specific instructional activities within each phase are also listed. There are no hard-and-fast rules to use all the instructional activities and teachers can select and use among the different instructional activities which they consider are relevant and feasible to the intended objectives, to the specific content, the learners' capability and the time allotted to teach the specific content.

The second part dwells on the techniques for implementing the five instructional phases of the active teaching (direct instruction) model. The techniques are described and presented with examples of how they could be used in teaching grade three mathematics. However, all the techniques presented in a pattern may not be used in a single lesson since all may not be appropriate for all the contents or lessons in grade three Mathematics.

The third part provides suggestions on questioning techniques since questions would help in checking students' understanding and hence a way of getting feed back. Questions should be thought of in a way they could serve the purpose and every lesson should include a section in which the teacher checks for student understanding of the various parts of the data that have been presented. Overt responses by the students (every pupil responses) are important and don't assume the student knows it.

The last part presents suggestions on how to teach grade 3 mathematics lessons. The lessons are taken from the mathematics textbook and most of the lessons could be taught using the suggested algorithms and teachers are advised to use them or else can come up with their own algorithms to teach the lesson step-by- step.

1. GUIDELINES FOR GRADE THREE ACTIVE MATHEMATICS TEACHING

As it was outlined, a direct instruction lesson proceeds through five phases: 1) Provide objectives and establish set; 2) demonstrate the skill or understanding that is the focus of the lesson; 3) provide guided practice; 4) check for understanding and provide feedback, and 5) assign independent practice. These phases are summarized below.

Table 1. Summary of the direct instruction model

1. Provide objectives and establish set (the first 5 minutes)
    a. Specify the behavior the students will be expected to perform
    b. Give background information
    c. Provide initial motivation and focus for the lesson /explain why the lesson is important
    d. Get students ready to learn
2. Demonstrate knowledge or skill (20 minutes)
    a. Demonstrate the skill correctly or present step-by-step information, but at a rapid pace
    b. Structure initial practice
    c. Model the behavior that the student is expected to perform (Focus on meaning and promoting student understanding by using lively explanations, demonstrations, process explanations, illustrations and so forth)
3. Provide Guided Practice (about 6 minutes)
    a. Initially guide students using controlled practice
    b. Use high frequency of questions and overt student practice
    c. Provide prompts during initial learning (when appropriate)
    d. Check for understanding by evaluating student response
    e. Continue guided practice until student responses are firm
4. Check for Understanding (CFU) and provide feedback
    a. Ask another question of the same student with acknowledgement of correctness after correct, quick and firm responses.
    b. Provide process feedback after correct but hesitant responses.
    c. Provide hints, probe, or change the question or stimulus to a simpler one that engages the student in finding the correct response after incorrect responses because of lack of knowledge
    d. Use praise in moderation specific praise is more effective than general praise.
5. Assign Independent Practice (about 9 minutes)
    a. Provide uninterrupted successful practice
    b. Maintain momentum: get everyone involved, then sustain involvement
    c. Alert students to the fact that their work will be checked at the end of the period
    d. Promote accountability - check the students work
    e. Practice until responses are firm, quick, and automatic

In the initial step of the direct instruction model (i.e. provide objectives and establish set), the intent is to get students' attention and to motivate them to participate in the lesson. Once students know the reason for participating in a particular lesson, and what is expected of them, the teacher then proceeds to the next step (i.e. present and demonstrate the learning materials).

This is followed by guided practice in which teacher assigns short, meaningful amounts of practice so that active practice can increase retention, make learning more automatic, and make it possible for the learner to transfer learning to new situations.

The next step (checking for students' understanding) is characterized by a teacher's asking students questions and students providing answers they think are correct. For best results feedback should be as specific as possible, be provided immediately following practice, and fit the developmental level of the learner.

The final phase of a direct instruction lesson is independent practice, or homework. Homework, or independent practice, is an opportunity for students to perform newly acquired skills on their own with less guidance and, as such, should be viewed as a continuation of practice, not a continuation of instruction.

In the following section techniques for implementing each of the five instructional steps are presented. Moreover, examples from grade three mathematics lessons are included in some of the direct instructional phases so as to make the techniques more feasible.

2. TECHNIQUES FOR IMPLEMENTING EACH OF THE FIVE INSTRUCTIONAL PHASES

2.1. Provide Objectives and Establish set

Regardless of the instructional model being used, good teachers always begin their lessons by explaining their objectives and establishing a learning set. To carryout this instructional phase, the following suggestions would help the teacher:

- Bridge comments which refer to previous learning
- Design motivational activities to gain students' attention and /or interest
- Communicate the objective to the learner
- State the purpose of the lesson, etc

The following example explains this initial step.

Eg. Remember yesterday we learned subtracting two digit numbers with "no borrowing". Today we will continue subtraction with "borrowing". The objective of today's lesson is to learn how to get difference by subtracting two-digits factors that require "borrowing ".

2.2. Present and demonstrate the learning material

The key to successful lessons is to present information as clearly as possible. In almost every lesson the teacher, through some means, presents information. However, the way the lesson is presented matters and clarity of instructions and presentation may be achieved practicing the suggestions given below.

Table 2. Aspects of Clear Presentation

1. Clarity of goals and main points a. State the goals or objectives of the presentation b. Focus on one thought (point, direction) at a time c. Avoid digressions d. Avoid ambiguous phrases and pronouns 2. Step-by-step presentations a. Present the material in small steps b. Organize and present the material so that one point is mastered before the next point is given c. Give explicit, step-by-step directions (when possible) d. Present an outline when the material is complex 3. Specific and concrete procedures a. Model the skill or process (when appropriate) b. Give detailed and redundant explanations for difficult points c. Provide students with concrete and varied examples 4. Checking for students' understanding a. Be sure that students understand one point before proceeding to the next point b. Ask students questions to monitor their comprehension of what has been presented c. Have students summarize the main points in their own words d. Reteach the parts of the presentation that the students have difficulty comprehending, either by further teacher explanation or by students tutoring other students

"Taken from Temechegn's Course Material (2002)"

Conducting Demonstrations

Direct instruction relies heavily on the proposition that much of what is learned comes from observing others. It is from watching teachers model particular behaviors that students learn to perform these same behaviors and to anticipate their consequences. To effectively demonstrate a particular concept or skill the following suggestions would help teachers prior to their actual classroom event.

- Acquire understanding and mastery of the particular skill
- Attend to rehearsal

2.3. Provide Guided Practice

Practice is an important element in the active teaching model and requires finesse to manage properly and such student practice should be guided by the teacher because guided practice increases retention, makes skills more automatic, and promotes transfer to new situations. The purpose of guided practice is to:

- Guide initial practice
- Correct errors
- Reteach, if necessary
- Provide sufficient practice so that students can work independently.

In guided practice, the teacher asks questions and initially provides prompts or guides the students in responding, and gives them feedback and corrective help when they make errors. Of course, all teachers spend time in guided practice. However, the more effective teachers devote more time to it. That is, they spend more time asking questions, correcting errors, repeating the new material, and working problems with teacher guidance than do the less effective teachers. The form of guided practice is modified to fit the lesson being taught. For example, when a process is being taught, as in long division or multiplication with carrying, the guided practice frequently consists of problems worked under the teacher's supervision, and the teacher restating the steps as the students proceed. Teachers frequently have some students doing the math problems at the board, thus providing models for the entire class.

When facts such as number facts are being taught, then there is less process feedback and more questions and answers during guided practice.

In summary, the following suggestions are helpful to teachers during guided practice.

1. Ask a large numbers of questions
2. Guide students in practicing the new material, initially using prompts to lead students to the correct response and later reducing them when students are responding correctly.

3. Check for student understanding (CFU). Some techniques are:

- Prepare a large number of oral questions before hand
- Ask many brief questions on main points, supplementary points, and on the process being taught
- Call on students whose hands are not raised in addition to those who volunteer
- Ask students to summarize the rule or process in their own words.
- Have all students write the answers (on paper or chalkboard) while the teacher circulates
- Have students write the answer and check them with neighbor
- At the end of a lecture /discussion write the main points on the board and have the class meet in groups and summarize the main points to each other

4. Provide feedback (in every phase). Some techniques include:

- Give often and regularly feedback
- Give feedback about the process
- Give encouragements

5. Correct errors
6. Reteach when necessary
7. Provide a large number of successful repetitions. i.e. practice as long as necessary so that the students understand it.

2.4. Check understanding and provide feedback (correctives and feedback)

This is the phase of a direct instructions lesson that is often characterized by a teacher's asking students questions and students' providing answers they think are correct. The teacher then responds to the students' answers.

When a teacher asks questions to check for students' understanding students' responses could vary and such responses are described in the following subsections, with some direct instruction strategies for handling them.

A) Correct, Quick and Firm

A moderate-to-high percentage of correct, quick and firm responses is important if students are to become actively engaged in the learning process. The teacher's response to a correct, quick, and firm student response is to ask another question of the same student. This increases the potential for feedback or, if time does not permit, to move on quickly to another question and student. When the teacher gets such student desired response, he/she is advised to acknowledge the response with such comments as, "Good," "Fine," "Excellent," "Correct," or other statements indicating satisfaction with the response.

B) Correct But Hesitant

This type frequently occurs in a practice and feedback session at the beginning or middle of a lesson. Still positive feedback to the student who supplies a correct but hesitant response is essential. When the student response is correct but hesitant the first teacher's feedback to provide in this instance should be a positive, reinforcing statement, such as "good," or "that's correct," because the correct but hesitant response is more likely to be remembered when linked to a warm reply.

C) Incorrect Because of Carelessness

When a student makes incorrect response because of his/her carelessness, the best procedure for the teacher is to acknowledge that the answer is wrong and to move immediately to the next student for the correct response. By doing so, a teacher will make a point to the careless student that he or she lost the opportunity for a correct response and the praise that goes with it.

D) Incorrect Because of Lack of Knowledge

Perhaps the most challenging response is incorrect because of a lack of knowledge. For such student response, it is better for the teacher to provide hints, probe, or change the question or stimulus to a simpler one that engages the student in finding the correct response than to simply give the student the correct response. After all, the goal is not to get the correct answer from the student, but to engage the learner in the process by which the right answer can be found.

Strategies for Incorrect Responses

The teacher may follow the most common strategies for incorrect responses such as:

1. Review key facts or rules needed for a correct solution
2. Explain the steps used to reach a correct solution.
3. Prompt with clues or hints representing a partially correct answer.
4. Take a different but similar problem and guide the student to the correct answer.

2.5. Provide extended (independent) practice

This ingredient in direct instruction is the opportunity for independent practice. Once the teacher has successfully elicited the behavior, provided feedback, and administered correctives, students need the opportunity to practice the behavior independently.

The teacher should perform the following activities to ensure that students become actively engaged in the practice he/she provides:

1. Direct the class through the first independent practice item. This gives the scheduled seatwork a definite beginning, and students who are unclear about the assignment can ask questions without distracting others.
2. Schedule seatwork as soon as possible after the eliciting and feedback exercises. This helps students understand that independent practice is relevant to the guided practice provided earlier.
3. Circulate around the classroom while students are engaged in independent practice, to provide feedback, ask questions, and give brief explanations.

4. Keep contacts short and focused on specific issues for which a brief explanation is adequate. In spending circulation time, try to average 30 seconds or less per student.
5. For difficult material in whole class instruction, have a number of segments of instruction and seatwork during a single period.
6. Arrange seats to facilitate monitoring the students (e.g. face both small group and independently working students)
7. Establish a routine to use during seat work activity which prescribes what students will do how they will get help and what they will do when they have completed the exercises.

Home Work

Most independent practice assigned to students as the final phase of a direct instruction lesson is homework. Following are general guidelines for independent practice given as homework.

1. Teachers should give students homework that they can perform successfully and it should involve the continuation of practice or preparation for the next day's content.
2. Teachers should provide feedback on the homework. One method of providing feedback is to involve other students in correcting the homework.

3. SUGGESTIONS ON QUESTIONING TECHNIQUES

Because questions are asked so often in classrooms, an obvious concern is what effects they have on student learning. Questioning is a tool for actively engaging your learners in the learning process.

At this point the teacher should ask himself/herself why am I asking this question. Hence, his/her first decision in using questions is to determine whether his/her lesson is teaching facts, rules, and action sequences (Type 1 Behaviors) or concepts, patterns, and abstractions (Type 2 Behaviors). Since grade 3 mathematics lessons involve primarily mastery of basic skills, there are good reasons for asking questions at the knowledge, comprehension, and application level.

Uses of Questions

Regardless of the classification, there are many specific purposes for which questions are used:

- To involve students in the lesson
- To provide a change of activity
- To introduce and develop a subject by recalling previous knowledge.
- To make contact with the class
- To convert difficulties and misunderstanding (i.e. wrong answers) into desired learning.
- To assess learning - Continuous feedback to teacher and class.
- To recall a student who has mentally left the lesson.

Even this substantial list does not cover all the reasons why questions are asked. Nevertheless, many other reasons for asking questions could be listed. The important question here is how does the teacher asks questions that promote learning. Following are suggestions for using questions.

1. Pose the question - pause - nominate (a student by name)
   The teacher allows time for students to think - wait-time. In other words, the teacher allows learners sufficient time to answer a question before calling on some one else or moving to the next question. After asking the question the teacher pauses for 3 to 4 seconds for lower-level questions before calling on some one else.
2. Try to use the answer to phrase another question.
3. Ask one question at a time, in logical order. Small steps at a time.
4. Distribute questions evenly around the class.

5. Look at the student when asking a question - it is vital that names are known. Personal recognition helps towards establishing good relationships in the class.
6. Make questions short and concise enough for students to remember
7. Make questions timely, interesting, thought provoking and relevant to the lesson being taught. Questions should be timed to stress key points
8. Pose questions so that more than a guessing response ("Yes/No", "True/False", "Right/Left") is required.
9. Phrase questions in such a way that the answers are not suggested in the questions.

Avoid

1. General questions - no one named
2. Questions that have an obvious answer.
3. Questions which have a number of equally good answers.
4. Questions such as:
   "Do you see what I mean?"
   "Do you all understand?"
   "Does anyone have any difficulty?"

Types and Levels of Questions

Questions may be classified according to the level of learning required for the correct response. In other words, questions can be classified in relation to lower order and higher order cognitive thought processes. The following classification is based up on Bloom's taxonomy and provides a manageable way of checking the balance of questions to be used in testing situations.

A) Knowledge/Recall

Your purpose here is to determine whether students can remember or recall information and recognize facts, terminology, and rules. You should avoid asking too many questions in this category. Questions will tend to begin with What, State, Name, Define, Describe, etc.

Examples: 1.What is the measure of length?

2. How many digits are needed to make the number 12?

B) Comprehension

The purpose here is to help students organize facts in such a way as to demonstrate understanding of principles, explain reasons etc. Words used in this type of question often include: Explain, Illustrate, Why, How, Give reasons, etc.

Examples: - 1. How many units are there in the number 12?

2. What are the changing values of digits when we write them in different places in a number (e.g. the value of 7 in: 7456, 1756, 1476 and 1457).

C) Application

Your purpose here is to encourage students to apply learning in a number of different situations. Here, student is able to apply the information learned to a context different than the one in which it was learned. Some action verbs you can use in formulating questions at the application level are: apply, demonstrate, employ, operate, solve, use, etc.

Examples: 1. Can you show me 12 pencils?

2. Use the symbols < and > for comparing 57 - 49

D) Analysis

Questions at the analysis level require the student to break a problem in to its component parts and to draw relationships among the parts. Hence, your purpose here is to help students not only to remember and organize information but also analyze it in order to identify underlying causes /effects/ problems etc. Some action verbs you can use in formulating questions at the analysis level are: breakdown, differentiate, distinguish, point out, relate, support, etc

Examples: 1) which of the boxes do not contain 12 things?

2) Which of the following pictures represents a straight line?

E) Synthesis

Questions at the synthesis level ask the student to produce something unique or original - to design a solution, compose a response, or predict an outcome to a problem for which the student has never before seen, read, or heard a response. Hence, your purpose here is to help students form relationships and put things together in new or original ways. Words associated with this level of question could include, Suggest, Develop, Formulate, Predict, Plan, Illustrate. etc.

Examples:- 1) What new numbers can you make by adding by 12s?

2) How would you make a straight line without using a ruler?

F) Evaluation

The purpose here is to help your students make sound judgments, for example, to consider the merit of an idea, finding or recommendation. Words associated with this type of question are Assess, Evaluate, Justify, Decide, Compare/Contrast etc.

Examples:- 1) Which of the following numbers contain multiples of 12?

2) Given the following lines, which are curved and which are straight?

N.B.

Because of their developmental level, grade 3 students should be presented with the first three levels (knowledge, comprehension and application questions) which tend to promote Type 1 behaviors in the form of facts, rules, and action sequences.

The Levels of questions provide guidance in developing a ·logical sequence of questions. Thus, the question sequence begins with questions at the knowledge level, followed by the comprehension level and then the application level.

Much is said on questions and the next point to be raised here is what to do with regard to student answers.

Student Answers

1. Reward correct answers with praise ("very good", "yes, a good answer").
2. Break down lengthy correct answers which cover several key points by asking other students to explain or expand individual points. Frequent lengthy responses may mean that the questions are poorly phrased.
3. If an answer is partially correct, give credit for the correct part, and concentrate on the incorrect part. e.g. "Are you quite sure that the second part of your answer is correct?" "Let's see if Solomon can help you."

4. TECHNIQUES OF TEACHING SOME SELECTED GRADE THREE MATHEMATICAL LESSONS AND USE OF ALGORITHMS

In the following section some lessons are taken from grade three Mathematics text book. After the lessons are discussed examples are provided on how such lessons could be taught using the active teaching strategies. Algorithms are also suggested for teaching grade 3 mathematics lessons so that you would be able to use them in your classrooms.

1. Place Value to thousands

The value of a digit depends on its place in the number. For example, look at the numbers 5984. What are the values of the digits?

Standard form	5,984
Read	5 thousand, 9 hundred, eighty, four
Write	Five thousand nine hundred eight four
Expanded form	5000+900+80+4

What digit is in the thousands place? what digit in hundreds? what digit in tens? and what digit in ones? Place value is the concept that allows the value of a symbol to depend on its placement in a number. For example, in the above numeral, the 5 has place value "thousands," the 9 has place value "hundreds," the 8 has place value "tens," and the 4 has place value "units". You could write 5984 in expanded form as.

5x1000+9x100+8x10+4x1

For each of the following numerals, give the place value of the underlined numeral

a. 9, 674 b. 894 c. 7, 432 d. 59

2. Rounding Whole Numbers

As part of the grade 3 mathematics syllabus you will find in the textbook rounding whole numbers. How could rounding be best taught? It may be well taught if certain steps are used for the purpose. Consider the following example:

Round 4,926 to the nearest hundred

Step 1. Find the rounding place 4,926

Step 2. Look at the digit to the right. If it is less than 5, leave the digit in the rounding place unchanged. If it is 5 or more, increase the digit in the rounding place by 1.

Step 3. Change each digit to the right of the rounding place to 0.

4,926
↓
4,926

2<5 then when 4,926 is rounded to the nearest hundred it becomes 4,900

Round 578 to the nearest ten

Solution: The rounding place is 7

Look at the digit to the right. That is 8. Since 8>5 the number 578 to the nearest ten becomes 580.

i.e. 5<u>7</u>8
↓
5<u>7</u>8

Since 8>5 the number becomes 580.

3. Comparing and Ordering Numbers

It is obvious that your expectation of students at the end of grade 3 Mathematics lesson would be their ability to compare and order numbers. To attain this objective the way you present the lesson matters.

You can use place value to compare the numbers.

For example, compare 5,879 and 5,350. Start at the left and compare digits in the same place.

5, 879
5, 350
↓ Same
↓ 8>3

So, 5,879 > 5,350

Compare the following numbers using >,< or = .

a) 479 and 497

Solution 479
497
↓ Same
↓ 7<9

So, 479 < 497

b) 4,679 and 4,679

4, 6 7 9

4, 6 7 9

Same Same

Same

Same

Since all the digits are the same 4,679=4,679

4. Algorithms for whole number Addition and Subtraction

(Adopted From A Problem Solving Approach to Mathematics by Billstein et al, 1998)

Along with knowledge of basic facts and properties, there could be the performance of more complex additions and subtractions. More complex operations are commonly done by applying various algorithms. An algorithm is a step-by-step systematic procedure used to accomplish an operation. Every elementary school teacher should know more than one algorithm for doing operations. Following are examples of algorithms that could be used for doing addition and subtraction.

4.1. Addition Algorithms

Suppose you wish to add 14+23. You show this computation with an introductory algorithm and the familiar algorithm in the following way.

a)

Tens	ones
1	4
+ 2	3
3	7

Introductory algorithm

b)

$$\begin{array}{r} 14 \\ +\underline{13} \\ 37 \end{array}$$

Familiar algorithm

Here, concrete aids could be used for grade 3 since such algorithm need to be taught developmentally; that is, they must proceed from the concrete stage to the abstract stage at appropriate times. After using concrete aids, children are ready to compute a computation such as, for instance, 28+34

a)

Tens	ones	
2	8	
+ 3	4	
5	$\not{1}\not{2}$	(Add)
+ 1	2	(Regroup)
6	2	

b)

```
  28
+ 34
  12  (sum of ones)
+ 50  (sum of tens)
  62
```

c)

```
  1
  28
+ 34
  62
```

Scratch Addition

The scratch addition algorithm allows students to perform complicated additions by doing a series of additions involving only two single digits. An example follows:

Add the numbers 87, 65, and 49

Step 1. 87, $6\not{5}_2$, $+\ 4\not{9}$ — Add the numbers in the units place starting at the top. When the sum is 10 or more, record this sum by scratching a line through the last digit added and writing the number of units next to the scratched digit. For example, since 7+5=12, the "scratch" represents 10 and the 2 represents the units.

Step 2. 87, $6\not{5}_2$, $+\ 4\not{9}_1$ — Continue adding the units, including any new digits written down. When the addition again results in a sum of 10 or more, as with 2+9=11, repeat the process described in step 1.

Step 3. $^{2}87$, $6\not{5}_2$, $+\ 4\not{9}_1$, 1 — When the first column of additions is completed, write the number of units, 1, below the addition line. Count the number of scratches, 2, and add this number to the second column.

Step 4. $\not{2}\not{8}_0 7$, $6\not{5}_2$, $+\ \not{4}_0\not{9}_1$, 201 — Repeat the procedure for each successive column.

Compute these additions using the scratch algorithm:

a. 296
840
+ 27

b. 1369
4813
5879
+ 6183

Solution

a. $^{1}2\,^{1}\not{9}_{0}6$
$\not{8}_{1}40$
$+\ \not{2}\not{7}_{3}$
1163

b. $^{2}1\ \ ^{2}3\ \ ^{2}6\ \ 9$
$4\ \not{8}_{2}\ \ \not{1}\ \not{3}_{2}$
$\not{5}_{2}\not{8}_{1}\not{7}_{6}\not{9}_{1}$
$+\ 6\ \ 1\ \not{8}_{4}\ 3$
1 8 2 4 4

4.2. Subtraction Algorithms

As with addition, you can also use here an introductory algorithm and familiar algorithm For example, take 36-24

a)

Tens	Ones
3	6
- 2	4
1	2

Introductory algorithm

b 36
- 24
12
Familiar algorithm

Subtractions become more involved when regrouping is necessary, for example as in 56-29. In concrete terms, 9 units cannot be taken from 6 units, so 1 unit must be traded for 10 units, giving a total of 16.

a.

Tens	Ones
5	6
- 2	9

⟶

Tens	Ones
4	16
- 2	9
2	7

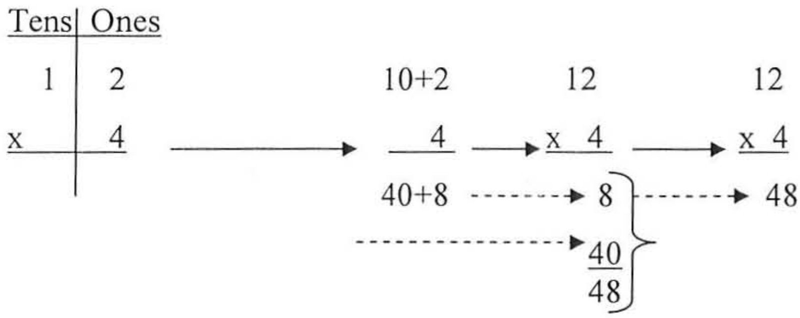
Introductory algorithm

b. $\overset{4}{\not{5}}\,^{1}6$
- 29
27
Familiar algorithm

5. Algorithms for Whole-number Multiplication & Division

5.1 Multiplication Algorithms

To develop algorithms for multiplying multi-digit whole numbers, you use the strategy of examining simpler computations first. Consider 4x12



The above algorithm illustrates the distributive property of multiplication over addition on the set of whole numbers.

Next you consider computations with 2 digit factors, such as 14x23. One possibility is to use the distributive property of multiplication over addition to write out all the partial products and add, as shown:

```
  14
x 23
  12   (3x4)
  30   (3x10)
  80   (20x4)
+200   (20x10)
 322
```

Another approach is to write 14 as 10+4 and use the distributive property of multiplication over addition, as follows:

14x23= (10+4) x23

=(10x23)+(4x23)

= 230 + 92

= 322

This last approach leads to an algorithm for multiplication

$$
\begin{array}{rl}
23 & \\
\times\ \underline{14} & \{10+4\} \\
92 & (4\times23) \\
+\ \underline{230} & (10\times23) \\
322 &
\end{array}
\qquad \text{or} \qquad
\begin{array}{r}
23 \\
\underline{\times\ 14} \\
92 \\
\underline{23} \\
322
\end{array}
$$

5.2. Division Algorithm

Division in most elementary texts is taught using a four-step algorithm: estimate, multiply, subtract and compare. An example of division by a divisor of more than one digit is given next. Consider $32\sqrt{2618}$.

1. Estimate the quotient in $32\sqrt{2618}$. Because 1x32=32, 10x32=320, 100x32=3200, you see that the quotient is between 10 and 100.
2. Find the number of tens in the quotient. Because 26÷3 is approximately 8, then 26 hundreds divided by 3 tens is approximately 8 tens. You then write the 8 in the tens place, as shown:

$$
\begin{array}{rl}
80 & \\
32\overline{)2618} & \\
-\ \underline{2560} & (32\times80) \\
58 &
\end{array}
$$

3. Find the number of units in the quotient. Because 5÷3 is approximately 1, then 5 tens divided by 3 tens is approximately 1. This is shown on the left in the following:

$$
\begin{array}{rl}
\underline{81} & \\
1 & \\
80 & \\
32\overline{)2618} & \\
-\underline{2560} & \\
58 & \\
-\ \underline{32} & (32\times1) \\
26 &
\end{array}
\qquad\qquad
\begin{array}{r}
81\ \text{R}\ 26 \\
32\overline{)2618} \\
-\ \underline{2560} \\
58 \\
-\ \underline{32} \\
26
\end{array}
$$

4. Check: 32x81+26=2618

GLOSSARY

Checking For Understanding: A technique used by teachers to see if students have grasped new information or skills that have been presented.

Corrective feedback: Information given to students about how well they are doing.

Direct Instruction: An approach to teaching basic skills and straightforward declarative knowledge in which lessons are highly teacher directed and learning environments are tightly structured.

Establishing Set: A technique used by teachers at the beginning of a lesson to prepare students to learn and to establish a link between their prior knowledge and the new information to be presented.

Explicit Instruction: Another term for direct instruction

Feedback: Information given to students about their performance.

Guided Practice: Practice assigned to students to be completed under the guidance or watchful eye of the teacher.

Independent Practice: An assignment given to students to accomplish on their own without the teacher's guidance to practice newly presented material.

Seatwork: Independent work done by students at their desks, such as reading, answering questions, and completing worksheets.

Wait-time: The time a teacher waits for a student to respond to a question.

APPENDIX II

A CHECKLIST FOR CODING IMPLEMENTATION OF INSTRUCTIONAL BEHAVIORS

Instructional Behaviors	Frequency of Occurrence During a 40 minutes period								TOTAL
	5	10	15	20	25	30	35	40	
1. Provide Objectives and Establish set 1.1. Did the teacher go over objectives for the lesson? 1.2. Did the teacher give background information? 1.3. Did the teacher explain why the lesson is important? 1.4. Did the teacher use motivational activities to gain students attention and/or interest?									
2. Demonstrate knowledge or skill 2.1. Did the teacher teach in small steps? (step-by-step presentation) 2.2. Did the teacher provide illustrations and concrete examples? 2.3. Did the teacher use demonstration and model during presentation? 2.4. Did the teacher start with simple example followed by more complex ones 2.5. Did the teacher use clear language? 2.6. Did the teacher make digressions? 2.7. Did the teacher give explicit, step-by-step directions? 2.8. Did the teacher teach to the objective? 2.9. Did the teacher present an outline? 2.10. Did the teacher give detailed and repeated explanations? 2.11. Did the teacher include the description or set of procedures? 2.12. Did the teacher make students summarize the main points in their own words? 2.13. Did the teacher use unnecessary technical terms? 2.14. Did the teacher use unexplained difficult vocabulary? 2.15. Did the teacher use algorithms while dealing with mathematical problems?									
3. Provide Guided Practice 1.1 Did the teacher give opportunity for students to practice the objective? 1.2 Did the teacher ask questions within guided practice? 1.3 Were the questions relevant to the content or skill? 1.4 Did the teacher provide prompts during guided practice? 1.5 Did the teacher continue guided practice until student responses are firm?									

4. Check for Understanding (CFU) and provide feedback 4.1. Did the teacher give additional explanations or process feedback during CFU? 4.2. Did the teacher ask another question after correct responses? 4.3. Did the teacher provide short statement of correctness after correct responses? 4.4. Did the teacher try to elicit an improved response when the one is incorrect? 4.5. Did the teacher ask pupils to give an example illustrating the content being taught? 4.6. Did the teacher provide specific praise?		
5. Independent Practice 5.1. Did the seatwork activity follow immediately after guided practice? 5.2. Were the exercises directly relevant to demonstrations and guided practice activities? 5.3 Did the teacher circulate among the students during seatwork? 5.4. Did the teacher make more than 30 seconds contact with individual students?		

APPENDIX III

Mathematics Test for Grade 3
(Translated from Tigrigna in Appendix IV)

1. What is the measure of weight?

   A) Meter B) Liter C) Gram

2. In 5724, which number is in the thousand's place?

   A) 5 B) 7 C) 2

3. When Two Thousand Four Hundred Fifty is written in figures

   A) 2045 B) 2054 C) 2450

4. The measure of length is

   A) Meter B) Gram C) Kilogram

5. In 4712, 7's place value is

   A) Tens B) Hundreds C) Thousands

6. 658 ____ 685

   A) < B) > C) =

7. When 629 is rounded to the nearest hundred

   A) 630 B) 620 C) 600

8. 2000+700+80+4= ☐

   A) 27804 B) 2784 C) 207084

9. 945 A) 356 B) 366 C) 256

   - 689

10. 456 A) 695 B) 705 C) 795

    +249

11. The place value of the underlined numeral in 9,799 is

    A) Tens B) Hundreds C) Thousands

12. 4 Kilometer is equivalent to ______ meter

    A) 4000 B) 400 C) 40

13. When 4603 is rounded to the nearest thousand

    A) 4000 B) 5000 C) 6000

14. 2700÷30 = ☐

A) 9 B) 90 C) 900

15. 1 Birr is equivalent to _______ cents

A) 25 B) 50 C) 100

16. 52 A) 1862 B) 1872 C) 1882

x 36

17. 32+10 _____ 20+12

A) < B) > C) =

18. When 2618 is written in words

A) Two hundred sixty eight

B) Two thousand six hundred eighteen

C) Twenty thousand six hundred eighteen

19. 249 A) 918 B) 1008 C) 1018

743

\+ 26

20. 479 x 36= ☐ A) 16,144 B) 17,246 C) 17,244

APPENDIX IV

ናይ 3ይ ክፍሊ ሒሳብ ፈተና

1. ናይ ክብደት መዐቀኒ እንታይ ይብሃል?

    ሀ) ሜትር　　ለ) ሊትር　　ሐ) ግራም

2. ኣብ 5724 ዓዲ ሽሕ ዝኾነ ቁፅሪ

    ሀ) 5　　ለ) 7　　ሐ) 2

3. ክልተ ሽሕን ኣርባዕተ ሚእትን ሓምሳን ብኣሃዝ እንትፅሓፍ

    ሀ) 2045　　ለ) 2054　　ሐ) 2450

4. ናይ ንውሓት መዐቀኒ እንታይ ይብሃል?

    ሀ) ሜትር　　ለ) ግራም　　ሐ) ኪሎ ግራም

5. ኣብ 4712 "7" ዓዲ __________ እዩ

    ሀ) ዓሰርተ　　ለ) ሚእቲ　　ሐ) ሽሕ

6. 658 ______ 685

    ሀ) <　　ለ) >　　ሐ) =

7. 629 ናብ ዓዲ ሚእቲ ክፀጋጋዕ

    ሀ) 630　　ለ) 620　　ሐ) 600

8. 2000+700+80+4=☐

    ሀ) 27804　　ለ) 2784　　ሐ) 207084

9. 945
-689　　ሀ) 356　　ለ) 366　　ሐ) 256

10. 456
+ 249　　ሀ) 695　　ለ) 705　　ሐ) 795

11. ኣብ <u>9</u>799 እቲ ተሰሚሩ ዘሎ ቑፅሪ ዓዲ ክንደይ እዩ?

    ሀ) ዓሰርተ　　ለ) ሚእቲ　　ሐ) ሽሕ

12. 4 ኪሎ ሜትር ክንደይ ሜትር እዩ?

    ሀ) 4000　　ለ) 400　　ሐ) 40

13. 4603 ናብ ዓዲ ሽሕ ክፀጋጋዕ

ሀ) 4000 ለ) 5000 ሐ) 6000

14. 2700÷30=☐

ሀ) 9 ለ) 90 ሐ) 900

15. 1 ብር ክንደይ ሳንቲም እዩ?

ሀ) 25 ለ) 50 ሐ) 100

16. 52 ሀ) 1862 ለ) 1872 ሐ) 1882
x36

17. 32+10 ___ 20+12

ሀ)< ለ)> ሐ)=

18. 2618 ብፊደላት እንትፅሓፍ

ሀ) ክልተ ሚእትን ስድሳን ሸሞንተን

ለ) ክልተ ሽሕን ሽዱሽተ ሚእትን ዓሰርተ ሸሞንተን

ሐ) ዕስራ ሽሕን ሽዱሽተ ሚእትን ዓሰርተ ሸሞንተን

19. 249 ሀ) 918 ለ) 1008 ሐ) 1018
743
+26

20. 479x36=☐

ሀ) 16,144 ለ) 17,246 ሐ) 17,244