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**THE EFFECTS OF STREAMING ON MATHEMATICS  
ACHIEVEMENT AMONG SECONDARY SCHOOL PUPILS IN  
KISUMU, KENYA**

**BY**

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**A THESIS SUBMITTED TO THE FACULTY OF EDUCATION IN  
PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE  
AWARD OF A MASTER OF EDUCATION DEGREE IN  
EDUCATIONAL PSYCHOLOGY OF KENYATTA UNIVERSITY**



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# DECLARATION

This thesis is my original work and no part of it has been submitted for examination to any other University.



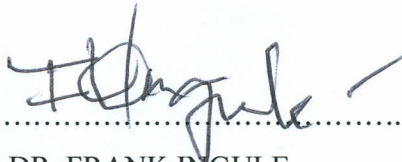
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## DEDICATION

The thesis is dedicated to my Father Christopher Shitsimi Mwashu for his support and encouragement in the course of my study.

Further my thanks are to the Principal of Njiru Boys' High school for the permission during the study period. Lastly but not least, I would pay special tribute to my mother for her support and encouragement throughout my degree.

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## ABBREVIATIONS

K.C.P.E.	-	Kenya Certificate of Primary Education
K.I.E.	-	Kenya Institute of Education
H.S.D	-	Honesty significant difference
ANOVA	-	Analysis of Variance

## ABSTRACT

This study investigated the effects of streaming on Mathematics achievement. The study examined whether the Learning setting played a significant role in determining pupil achievement and whether the effect of the Learning setting depended upon the Ability level of the pupils.

The subjects of the study consisted of Form Three Secondary School pupils (N=48). Purposive sampling was used to select an urban secondary school that streamed its pupils according to Ability. A stratified random sampling technique was used to select the subjects. The stratifying criteria was pupil Ability as determined by end-of-year examination results.

A factorial research design was used. The factors studied were: the Learning setting and the Ability levels. The Learning Setting had two levels namely the Individual Learning Setting and the Group Learning Setting. Ability had three levels namely high-ability, medium-ability and low-ability levels. The dependent measures used were the total error scores on two Mathematics tests namely Algebra and Logarithms and Indices.

The instruments used for data collection were; two Mathematics achievement tests, an Observation checklist to obtain data on interaction in groups; a pupils Questionnaire to determine the pupils' views on streaming; and Learning materials. The tests were administered under examination conditions. The observation data was collected by trained research assistants, while the pupils' Questionnaire was completed immediately after doing the tests.

Two-way factorial Analysis of Variance was used to identify the significant effects of the Learning setting and that of Ability on the total error scores, on both Algebra and Logarithms and Indices. It was also used to identify the interaction effects of the Learning setting and Ability on the total error scores. For the Learning setting, the F-values of 3.749 on Algebra and 0.13 on Logarithms and Indices were not significant ( $P < .05$ , 1, 42 DF). For Ability, the F-values of 3.966 on Algebra and 13.58 on Logarithms and Indices were significant ( $P < .05$ , 2, 42 DF). For the interaction of the Learning setting and Ability, the F-values of 1.562 on Algebra and 0.128 on Logarithms and Indices were not significant ( $P < .05$ , 2, 42 DF).

ANOVA was also used to test the effects of the Mathematics Tasks and its interaction with the Learning setting. For the Mathematics tasks, the F-value of 10.232 for high-ability pupils was significant ( $P < .05$ , 1, 20 DF), that of 3.158 for medium-ability pupils was not significant ( $P < .05$ , 1, 44 DF) and that of 0.011 for low-ability pupils was not significant ( $P < .05$ , 1, 20 DF). For the interaction of the Learning setting and the Mathematics Tasks, the F-values of 0.605 for high-ability pupils and 0.161 for medium-ability pupils were not significant ( $P < .05$ , 1, 20 DF) and  $P < .05$ , 1, 44 DF) respectively. For the low-ability pupils, the F-value of 4.825 was significant ( $P < .05$ , 1, 20 DF).

The above findings indicated that the Learning setting had no significant effect on the performance of the pupils. However descriptive analysis pointed to a clear cut effect though it was insignificant. There is therefore need for replicating the study, with a larger sample of pupils and also requiring more time for the pupils to master the Tasks properly. The study can also be replicated using tasks in other subjects than Mathematics. However, Ability had a significant effect on the performance of the pupils as expected. The performance at each Ability level was however seen to depend on the Learning setting though the interaction effect of the Learning setting and Ability was not significant on both the tasks. The medium-ability and low-ability pupils greatly benefited from the Group Learning setting while the Individual setting seemed to favour the high-ability pupils.

Analysis of group interaction indicated that the high-ability pupils in nearly every group directed the group-work and delegated work to other members of the group. They thus engaged in peer tuition. The high-ability pupils were able to locate their own area of difficulty by giving explanations. This was quite necessary for high achievement. The medium-ability pupils rarely explained how to carry out calculations but received explanations about them. The low-ability pupils rarely participated in setting up algorithms but often solicited and received explanations from other members. This must have led to their increased performance.

When asked to indicate their preferences, the high-ability pupils showed no preference for any one of the Learning settings. The medium-ability and low-ability pupils showed clear preference for the Group setting. The high-ability pupils indicated they liked the streaming practice used in their school. Half of the medium-ability pupils

liked the system while the others did not. All the low-ability pupils did not like the streaming practice and thought it did little to help them learn better.

From the findings, it was recommended that mixed-ability group discussions should be encouraged in secondary schools. Peer-to-peer teaching should thus be encouraged especially given our very large classes and teacher's inability to attend meaningfully to individual needs in a classroom. Secondary schools should have classes with pupils of mixed-ability. All the pupils be provided with appropriate learning materials. The practice of streaming should be discontinued. It was also recommended that the study be replicated using a larger sample and requiring more time and also in other subjects. A similar study should also be carried out at other levels of education like primary schools, colleges and the University.

# CHAPTER ONE

## INTRODUCTION

### 1.1 BACKGROUND TO THE STUDY

Streaming is a placement method used to organise pupils of similar-ability into Learning units. The Learning units are sometimes small groups of four or five pupils or they may constitute a whole class of about forty pupils. Some schools in Kenya prefer using this method to establish their classes. Other school administrators favour Learning units consisting of pupils of mixed-ability. The decision to establish Learning units have thus been made with varied reasons to support them (Kelly, 1978. p6).

The Learning units constitute three categories of pupils namely those of high-ability, medium-ability and those of low-ability according to achievement test results. Those of high-ability have better capacity of understanding and interpreting the tasks that are presented to them. Those of medium-ability have an average capacity of interpreting and understanding the tasks presented to them while those of low-ability generally have difficulties in understanding the tasks presented to them and need some special kind of aid to enable them interpret and conceptualise the tasks. A school that discriminates among these three categories of pupils and places them in different Learning units, is said to stream its pupils according to Ability (Barker-Luun, 1970).

The most important question that arises from this kind of placement practice is whether it has any significant effect on the learning outcomes of pupils, of given Abilities. A study in Britain by Daniels (1961 a) noted categorically that streaming created a Learning setting that was seen to benefit the bright pupils while it had a devastating effect on the learning opportunities of the low-ability pupils. According to Webb (1980) streaming encouraged the pupils in a Learning unit to engage in individual learning since the pupils could not offer help to each other. Streaming therefore was seen to create an Individual Learning setting. Webb's (1980) study also showed that

merely participating in a teacher/learner relationship was not sufficient for achievement. It is of major concern that the low-ability pupils do not benefit from the Individual Learning unit and therefore an alternate mixed-ability Learning unit could to some extent be more appropriate.

In Kenya, Kimokoti (1982) found that most of the secondary schools placed their pupils in mixed-ability Learning units. Such Learning units consisted of pupils of varying Ability mixed together to form one Learning unit. This kind of Learning setting allowed pupils within the unit to consult with one another in case of difficulties. It was quite obvious that the low-ability pupils would benefit from the presence of the high-ability pupils (Kelly, 1978). Even though most schools had classes of mixed-ability pupils, (Kimokoti, 1982) there were a few that still practised streaming.

There is however no agreement on the best method of establishing Learning units, Wawire (1996) reported mixed feelings among teachers on the best method of establishing Learning units. Some teachers felt that streaming was good because it ensured that bright pupils made maximum progress without being held back by the poor pupils. These teachers looked at the time and input needed for the bright pupils to help the poor pupils as a setback to their own learning. Donelan and Mayer (1994) however observed that teachers who favoured non-streaming claimed that the average and slow pupils did better in the mixed-ability setting benefiting from the presence of the bright pupils. They observed that the levels of motivation for the low-ability pupils were higher in the mixed-ability setting than in similar-ability settings.

Jackson (1964) and Barker-Lunn, (1970) reported in their studies that Primary schools streamed their pupils within the classes. In this case small Learning units were created and the pupils learnt according to how fast they moved. Dar and Resh (1986) argued that streaming enriched the Learning setting for the bright pupils while impoverishing it for the weak pupils. By this they meant that high-ability pupils had individual instructional materials like text-books that encouraged a lot of individual reading. On the other hand the low-ability pupils though they may have the Learning materials, they found it rather difficult to use them on their own. They saw pupils themselves, as being Learning resources for each other. Streaming was thus seen as having a devastating effect on the learning opportunities for the weak pupils. A similar view was expressed in a study by Braddock and Slavin (1993). They viewed mixed-ability grouping as a way of distributing learning resources, which included the pupils

themselves. They found that in most schools the high-ability pupils received the best resources while the weak pupils received the worst.

In Kenya, different ways were used to establish Learning units in Secondary schools. The most common one being on first come first served basis. This meant that after the Form One selection, the pupils were placed into classes in the order in which they reported to schools. The first ones to arrive filled one class while the next pupils were placed in the next class. This trend was continued until all the classes were filled. It was quite likely that the brightest pupils reported to the schools first and the weakest last. Such schools may somehow unknowingly be streaming their pupils according to Ability. In most schools, the same classes were maintained up to final year of study. It was equally likely that mixed-ability classes would result from the above method.

Some secondary schools purposively streamed their pupils as soon as they were enrolled in Form One. The pupils were placed in classes according to performance in K.C.P.E. examination. The top pupils were placed in one class while the weakest pupils were placed in another class (Wawire, 1996). Such schools later used the end-of-year examination results to re-allocate the pupils in the following year. This resulted in a yearly shifting of the pupils.

Though teachers may have mixed feelings about the most appropriate method of establishing Learning units, the effect of the Learning setting thus created on achievement was the concern of this study. The design of a Learning setting is therefore quite important since different kinds of Learning settings encourage and optimise certain kinds of behaviour while minimising and discouraging others. For instance the high-ability pupils put in one Learning unit may highly compete with each other, and therefore the Learning unit may promote competitive instincts. A mixed-ability setting may on the other hand encourage co-operation among all the members of the Learning unit. Whereas the high-ability pupils in a streamed setting may always feel that they are the best, the low-ability pupils always feel they are backward and would not perform any better no matter how hard they tried.

Glaser and Nitko (1971) observed that the learner interacts with the Learning environment, changes it and is in turn changed by the consequences of his actions. It is therefore quite important that before a school decides on which method to use for establishing its Learning units for its pupils, it must consider the kind of Learning environment that is being created. The current study was designed to explore the

effect of the Learning setting on Mathematics achievement with pupils from a school that streamed its pupils according to Ability.

## 1.2 STATEMENT OF THE PROBLEM

Streaming is a method of establishing classes used by educators who believe that it encourages competition among secondary school pupils. They argue that the method motivates the low-ability pupils to move to the upper streams (Barker - Lunn, 1970). A study by Daniels (1961a) however disputes this view. It says that non-streaming results, on average, in an improvement in the intellectual and scholastic progress of the pupils in all Ability levels. The study also shows that the increase in Ability and attainment is achieved without any noticeable holding back of the brighter pupils. This shows that the main effect of mixed-ability classes is a pulling up of the more backward children.

Research by Douglas (1964) in Britain showed that streaming led to the improvement of pupils in the upper streams while those in the lower streams deteriorated. The study showed that at each level of Ability children in the upper streams improved their scores while those in the lower streams deteriorated. One would therefore ask: Does the streamed Learning setting play a significant role in determining pupils achievement? Does the effect of the Learning setting depend upon the Ability level of the pupils? There is therefore an urgent need to identify the effects of the Learning setting created by streaming and understand why they are beneficial or detrimental to achievement in secondary schools.

A Learning setting that encourages individual work is seen to be motivating for the high-ability pupils while demotivating for the weak pupils. The mixed-ability Group setting, on the other hand is seen to benefit the poor pupils. It appears they all benefit by interacting in mixed-ability groups with the high-ability pupils. A systematic study of the effect of Learning Setting (Individual or Group) on Mathematics achievement of pupils from a streamed school was quite necessary. It was also important to study the nature of interaction initiated by each pupil in the Group setting. This was to determine whether the nature of interaction was related to achievement in the Group setting. It was also necessary to tap the pupils views about the Learning setting they preferred.

More specifically, the current study was to answer the following questions.

- a) Does the streamed Learning setting influence pupils achievement?
- b) How do different Learning settings affect pupils of different Abilities?

### **1.3 PURPOSE OF THE STUDY**

The purpose of the study was specifically to:-

1. Investigate the differential effect of the Learning setting on achievement of pupils with varied Ability.
2. Analyse the nature of interaction among members of mixed-ability groups to help understand how it influences pupil performance.
3. Determine the pupils views about the placement method that was used in setting up classes (Learning units).

### **1.4 SIGNIFICANCE OF THE STUDY**

The study was undertaken to show whether the Learning setting created by streaming affected the learning outcomes of pupils of varied Abilities. The study was to empirically determine the significant effects of streaming on pupils' achievement, given that the streaming practice was adopted by some secondary schools in Kenya. The study was also to give an analysis of the Group learning activities that helped to explain the increased performance of pupils of varying Ability. The perception of pupils on the streaming method of establishing Learning units was also determined. This was to provide a rationale for teachers to determine the Learning setting that was most appropriate to meet the needs of pupils of all Abilities.

The findings are of great importance to headteachers, teachers, educational policy makers and parents in Kenya. It was hoped that the result would be useful to most, if not all schools in Kenya.

### **1.5 ASSUMPTIONS OF THE STUDY**

The following assumptions were made:-

- 1) There was no differential teacher effect on the out come of this study.
- 2) It was assumed that the materials and tasks were new and the pupils had not had any prior information on the topics and had no access to additional tuition materials during the course of the experiment.

## 1.6 DEFINITION OF TERMS

The following technical terms were used in the study:-

**Streaming:** Placing pupils into Learning units with a set of learners who lie within the same Ability range.

**Mixed -Ability Group:** A group consisting of pupils from the high, medium and low-ability levels as determined by achievement test results.

**Learning:** The modification of behaviour brought about by the school environment, the instructional means designed by the educator, and the education system.

**Error scores:** Three types of error scores were obtained for further analysis. These were:-

- a) **Algorithmic errors:** Errors made due to poor understanding of predetermined guidelines, formulas or steps for arriving at the correct solutions.
- b) **Computational or Algebraic errors:** Errors that are unrelated to the steps required in setting up or carrying out the algorithm.
- c) **Total error score:** Number of errors made by a pupil on each task.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.0 INTRODUCTION**

This chapter contains a critical review of literature on the effects of streaming on academic achievement. As noted, little research on streaming has been done in Kenya and therefore the bulk of critical review comes from outside Kenya sources. The chapter is organised into five sections. The first section provides a theoretical rationale on the problem of streaming. The second explains the relationship between the Learning setting and Academic achievement. The third section highlights the extent to which streaming is practised. The fourth section provides a summary of the literature review while the last section gives statements of the research hypotheses generated based on the review of literature.

#### **2.1. THEORETICAL RATIONALE**

The design of a Learning setting should be aimed at catering for pupils of all Ability levels. Many teachers of Mathematics believe in learning by discussion in the acquisition of Mathematics skills. Hetherington and Parke (1993) were influenced by Vygotsky's social cultural theory to provide a framework for the problems the low-ability pupils experienced in Mathematics classes in streamed schools.

According to Vygotsky's social cultural theory, development is as a result of the interaction between the child's social world and his cognitive development. The theory stated development as a product of the social interaction between partners who jointly

solved problems together. Therefore through the assistance provided by others in his social environment, the child gradually learned to function intellectually on his own as an individual. The theory emphasises the input from the child's society in form of interactions with more skilled adults and peers as the best way of moulding the child's innate Abilities into more complex cognitive functions. Vygotsky stressed the importance of tools such as language and algebraic symbols that were required to permit the child to function more effectively in solving problems. By this, the theory implied that when children had guidance of more capable peers they were often able to carry out tasks they could never complete themselves. Therefore problem solving and memory could be improved when guidance was provided by more skilled partners. Vygotsky proposed *scaffolding* as an instructional process whereby the type of support offered to the child was modified to suit the child's Abilities withdrawing support as the child became more skilled. The child could then execute the task in a skilled fashion independent of adult or peer help (Paris, Hall, Hoffman and Schell, 1988).

According to Vygotsky's theory, a Learning setting should consist of pupils of mixed-ability, so that the high-ability pupils who are presumed to be more skilled, could provide guidance to those of low-ability to solve specific problems. In a streamed school, the Learning settings were such that all the low-ability pupils were placed in one Learning unit and therefore no skilled partner was present to provide help in moulding their Abilities. A streamed setting, according to the theory, did not promote social interactions between partners but allowed the partners to engage in individual learning. Since the low-ability pupils cannot get help from their unskilled partners they try to solve the problems on their own and make many errors in the process. According to Vygotsky's theory, the child's innate Ability level interacted with his Learning setting in order to realise the positive outcome in his intellectual growth. The mixed-ability setting was thus seen as the most effective Learning setting especially for the low-ability pupils.

Brainerd (1978) observed that other than just the Learning setting and Ability, other psychological factors also rigidly controlled the sequence in which content was presented to the pupils. Studies by Wohlwill, 1959; Wohlwill & Lowe, 1962; Beilin, 1965; Botvin and Murray, 1975; showed that, the active learning condition when first presented to pupils predicted more learning than the passive condition. According to Brainerd (1978) the pupils in a mixed-ability setting were to discuss the tasks presented to them first before they could solve them on their own. The mixed-ability group Learning setting was therefore seen as more stimulating when presented to the

pupils. Hebb (1949) Brunner (1962) and Bloom (1964) have also shown that intelligence is not fixed but grows and develops and is dependant on environmental stimulation.

The social cognitive theory by Bandura (1986) also offers explanation on how streaming affects the learning outcomes of the pupils. The theory gave a position that the environment or presence of others influenced behaviour. Pupils learn many things by observing their peers. For example in a mixed-ability setting, the low-ability pupils could learn tasks by observing the high-ability pupils executing them. They would in turn also try to execute the same tasks. In a similar-ability setting, the low-ability pupils would observe their peers passively involved in executing the tasks and would also remain passive. Bandura (1986) come up with the theory of self-actualisation and outcome expectation as two cognitive processes that influenced behaviour. Outcome expectation is one's belief that behaviour would produce a specific effect. For example in a streamed setting the low-ability pupils are guided by the efficacy belief that they are poor and under whatever circumstance they cannot achieve any better. The high-ability pupils on the other hand believed they were the best and therefore struggled to maintain their positions at the top. This showed that children's learning patterns may have been due, not only to social modelling factors but also to their personal convictions and cognitions.

In summary it is clear that the dynamics of a Learning setting has an effect on the learning outcomes of the pupils. Different kinds of settings encourage certain behaviours while minimizing and discouraging others. The school is a place where all pupils are to benefit from education. According to the theories cited above, streaming generally provides a Learning setting that is detrimental to the learning opportunities of the low-ability pupils while benefiting the high-ability pupils only.

## **2.2 RELATIONSHIP BETWEEN THE LEARNING SETTING AND ACADEMIC ACHIEVEMENT**

Most studies have noted a link between the Learning setting and Academic achievement (Gamoran, 1993; Braddock and Slavin, 1993; Donelan & Mayer , 1994). A co-operative group learning strategy was found to improve computer achievement of the pupils. This was found by a study carried out by Mc Lnerney et al (1997) on training within a co-operative group-learning context on computer achievement. It was observed

that the pupils were always helping each other to learn computer skills where they had difficulties.

Braddock and Slavin (1993) and Donelan and Mayer (1994) have in their studies shown marked differences in attainment of pupils in mixed-ability classes and in same ability classes. They showed using descriptive statistics that low-ability pupils in mixed-ability classes had higher mean scores on achievement tests than those in same-ability classes. The studies showed that classroom composition according to Ability had a significant effect on the academic achievement of the pupils.

Lukhoba (1988) in Kenya studied three schools in Busia District, two of which were streamed and one was not. A sample of 274 pupils was drawn from a Girls' boarding, a Boys' boarding and a co-educational day and boarding school. Composite test scores from Mathematics, English and Biology were used for analysis using the chi-square non-parametric method. This method was quite appropriate because there was no control for experimental comparisons, no manipulation of the independent variables and generally little control on intervening variables. The study therefore lacked the rigour of experimental design. Interaction of grouping and achievement was mediated by intervening factors such as school type, gender and socio-economic status. No relationship was found between the Learning setting and Academic achievement. Lukhoba's study had the gender variable being analysed independently of the grouping variable. Parametric tests such as F-test have a high power of efficiency in detecting difference as significant whereas non-parametric tests are likely to lead type two error, to accept a false null hypothesis especially if the population is normally distributed.

On the other hand Sorensen and Halliman (1986) carried out an investigation on the effect of the Ability grouping on growth in Academic achievement. The data came from 48 classes of elementary school children on Mathematics and Reading. A comparison of reading achievement gained in classes that were grouped and those that were not grouped according to Ability was made. The interaction effect of Ability and Grouping attained significance for high-ability pupils. This meant that better opportunities for learning existed in the high-ability than the lower level groups. For low-ability groups, the interaction effect of Ability and Grouping was not significant. In the study, the independent measures of pupil Abilities and efforts were not stated. Ability grouping also appeared to increase inequality in educational outcomes. Pupils assigned to high-ability groups were taught more than those in low-ability groups, thus had better opportunities for learning. The study found that Ability grouping increased inequality in

achievement. It however saw that the magnitude of the differences in opportunities for learning depended on differences on total instructional time devoted to teaching. Sorensen and Hallimans study also looked at the unequal way the Learning resources were distributed and found that the high-ability group was being favoured.

Dar and Resh (1986) in their study, confirmed that the intellectual dimension of the pupil was the strongest variable that predicted high academic achievement. They used a quasi-experimental comparison between two treatments; heterogeneous homeroom classes and homogenous classes of low and high-ability. The sample consisted of 700 tenth, eleventh and twelfth grade pupils from six Kibbutz high schools in Israel. The schools practiced Ability grouping in English, Mathematics and Hebrew grammar. In both cases, it was possible to access the environmental effects in terms of transition from a richer to a poorer Learning environment and vice-versa.

The regression analysis confirmed predominance of the Ability component both as a personal and classroom resource. The socio-economic component added less than one percent of the variance while ethnic origin had no effect. Ability/achievement accounted for 70.2%, of achievement variance while classroom level added 5%. Classroom composition by Ability was seen to contribute distinctly to explaining pupil achievement. The richer the composition the better the pupils' chances of higher achievement. The poor composition would thus have a stronger negative effect on the low-ability pupils. The study focused on how Ability was a very strong variable in predicting achievement. It however emphasised the disadvantage the low-ability pupils had in their own Learning setting. Thus confirming that streaming was likely to be highly beneficial to the high-ability pupils but was likely to be devastating to the learning opportunities of the low-ability pupils. The current study used a school that streamed its pupils according to ability, but from only one Form. The effect of the Learning setting was also assessed by comparing the performance of the same pupils under two different Learning settings.

In a related study Slavin and Karweit (1985) investigated the effects of three methods of dealing with pupil instruction: Individualized instruction, Ability grouping and Whole class instruction. The Whole class method emphasized a high ratio of active teaching by outstanding effective traditional teachers. The Ability-grouped method was employed for two Mathematics groups. The team assisted Individual method was also used. Here the instructor assisted the pupils on how to use instructional materials. Forty-five pupils in 15 (Grades 4-6) classes were assigned randomly to the three experimental treatments earlier described. The Whole class teaching had a consistent sequence of

teaching, controlled practice and independent seatwork and homework. The Ability grouped method divided pupils into groups of varying Ability while the Individual group learnt individualized Mathematics material at their own levels. The materials used for this were the self-instructional units, answer sheets and tests for objectives. The achievement criterion was the Mathematics computations and concepts sub-scales on the Comprehensive Test of Basic Skills (C.T.B.S). Pupils and teachers in all treatments were observed to determine whether they were implementing the critical features of their treatments. Using the random-effects nested Analysis of Variance using class means with treatment and class and teacher within treatment as factors, it was revealed that the Individual instruction and Ability group means were nearly identical but substantially higher than the active teaching method.

In a second experiment using different pupils, an untreated control group was added to the three treatments. The analysis of Experiment 2 was the same as that of Experiment 1. The Individual instruction and Ability group instruction were seen to increase computation skills. These two instructional methods were thus seen as being able to offset to some degree losses in instructional effectiveness due to the styles of teaching by traditional teachers. The study showed that the normal classroom teaching played a very small role in predicting Mathematics achievement and other methods of instruction were needed to supplement the classroom teaching. As seen in the above study, Individual instruction or Ability group discussions were quite necessary for high academic achievement.

Wilkinson and Spinelli (1983) investigated second and third grade pupils' use of requests and responses in their instructional groups of varying Mathematics Ability in America. Forty-three pupils in a combined second and third grade class with 24 boys and 19 girls were used. The pupils were assigned to small groups and given seatwork problems. The pupils were instructed to consult each other in the group for help and to co-operate with other pupils in the group for help. Each group had one high-ability, two medium-ability and one low-ability pupil. After completion of a ten-day unit of instruction, the pupils were tested individually to assess the comprehension and application of the concepts taught.

A total of 6,963 utterances were recorded in which 1478 (21%) were requests for information. Kruskal-Wallis analysis for overall Mathematical knowledge revealed significant differences in Ability among 11 Mathematical concepts ( $X^2[10] = 22.43, P < .05$ ) and for the three levels of Maths ability ( $X^2[2] = 11.49, P < .01$ ) Also significant

differences of achievement among 11 groups ( $X^2 [10] = 20.96 P < .05$ ) and for three levels ( $X^2 [2] = 9.8, P < .01$ ). It was found that the characteristics of requests were correlated and whether a request received an appropriate response depended on the characteristic of that request. The log-linear effect of each characteristic was calculated. The results showed that the two characteristics predicted appropriate responses. The proportion of direct requests was positively related to Mathematical achievement. The study thus gave clue of the fact that initial differences in interaction can be increased with a well structured group.

Webb and Cullian (1983) demonstrated the importance of group interaction for learning in junior high school classrooms in Los-Angeles. They used one hundred and five pupils in four classes. All pupils first learnt a unit on consumer Mathematics. Three months later half learnt a one-week unit on area and perimeter while the other half learnt a one-week unit on probability. The Mathematics classes at the school were streamed by Ability. The study found that group interaction was predicted by group composition by Ability and pupil personality. The frequency of asking and answering questions was higher among extroverted than introverted pupils. The more frequently the pupils received no answers to their questions, the lower were their scores on achievement tests. Pupils in uniform-ability groups were more likely than those in mixed-ability groups to receive no answers to their questions. It was therefore seen from Webb and Cullian (1983) study that uniform-ability groups were likely to be detrimental to low-ability pupils.

Webb (1980) investigated the influence of the mixed-ability Group setting on achievement of new and previously learnt material. Five groups of four pupils were selected from a pool of one hundred and eighty one eleventh grade pupils from three high schools in North California. Using descriptive statistics, the findings of the study revealed that high-ability pupils did best in the Individual setting while low-ability pupils did worst. High-ability pupils did worse in groups, medium-ability pupils did the same whether in groups or individually while the low-ability pupils improved markedly in the Group setting.

Webb's (1980) study also found that group interaction was differentiated. In the group setting high-ability pupils spent much time explaining the tasks The low-ability pupils did not participate in giving explanations but often solicited or received explanations. In the group, other members also made sure that the low-ability member understood the steps. A high correlation was therefore seen between Ability and Group

interaction. High-ability pupils gave descriptions and explanations more than low-ability pupils. Correlations ranged from 0.39 to 0.78, all significant at  $P < .04$ . Low-ability pupils, received explanations more often than high-ability pupils. Correlations ranged from 0.54 to 0.71, all significant at  $P < .01$ .

In summary, the studies reviewed indicated that Ability contributed significantly to the performance of pupils on achievement tests. Therefore pupils of high-ability, performed best, those of medium-ability performed better while those of low-ability performed worst. The studies have also shown that Learning setting also had a significant effect on the learning outcomes of the pupils. The Individual Learning setting was seen to greatly benefit the high-ability pupils while the mixed-ability Group setting greatly benefited the low-ability pupils. It was therefore noted that group interaction was a good predictor of high achievement. The more frequently the pupils received answers to their questions, the higher were their scores on achievement tests. The studies also indicated that normal classroom teaching played a very small role in predicting achievement. It was therefore necessary to have other methods of instruction to supplement the classroom teaching. The Individual instruction and Group interaction methods are thus seen to be quite necessary for high achievement.

### **2.3 THE PREVALENCE OF STREAMING PRACTICES**

Research findings have been fairly consistent with regard to the extent to which streaming was practiced. Wawire (1996) in Kenya collected information on the experiences of pupils in a streamed school. Using a questionnaire and personal interviews, it was found that some schools practised streaming without knowing it. The study reported unequal allocation of resources to the pupils in various streams and different attitudes from teachers. Different opinions were however given on which setting the pupils preferred. The high-ability pupils favoured the streaming procedure while the low-ability pupils favoured the mixed-ability method of establishing classes.

Kimokoti (1982) in a survey on the extent to which streaming was practiced in Kenya, found that there were different streaming patterns portrayed in various schools. This study found that the majority of schools favoured mixed-ability grouping. No explanation was given as to why most schools favoured mixed-ability grouping.

Ferri, (1971) carried out a study to find out which Secondary schools pupils from streamed or unstreamed primary schools were allocated to. Eighty three schools

participated in the study. Predictably, streaming was found to be the most prevalent form of organization in secondary school. The majority of secondary modern and comprehensive schools were streamed and only in grammar school was streaming not found to be popular. When the test results from the two schools were compared, there was very little difference in the average attainment of pupils who attended streamed or non-streamed schools. However the significant numbers favoured the non-streamed schools.

Levy and Tucker (1972) carried out a study in Midlands Britain to find the differential effects of streaming on primary school attainment. They found out that some schools were designated as streamed while others unstreamed by consensus among the staff of the local guidance clinic. They used eight schools designated as streamed and five as unstreamed. As reported earlier very few differences were noted between the two kinds of schools. This further gave evidence that schools were practicing either streaming or non-streaming. Daniels (1961) found that non-streaming significantly increased the intelligence quotient and mean score of junior pupils in Reading and English tests.

In the absence of guidance, many schools therefore adopt the policy of either streaming or unstreaming without considering their desirability or undesirability (Kelly, 1978,p.7). Studies done in the area of streaming have noted a link between streaming and academic achievement. Most studies have shown that streaming had a devastating effect on the low-ability pupils while it benefited the high-ability pupils.

In Kenya according to the literature cited, no study examined the effect of streaming on Mathematics achievement using the experimental or the factorial design. It was therefore hypothesized that there was a significant interaction effect between Ability and the Learning setting. Although some educators favour streaming in establishing their Learning units, the opposite has been reported by several studies. Most of the studies cited have shown that mixed-ability grouping is a better method of establishing Learning units to enable pupils from all the Abilities benefit from the method.

The cited literature above suggests that outside Kenya, schools were known as being either streamed or unstreamed and pupils were admitted purposively depending on which school they preferred. In Kenya however, it was noted that schools were not known as being streamed or unstreamed. Streaming was however noted to be in practice in some schools though the administrators did not know that they were actually streaming the pupils according to Ability. However, from the literature cited, mixed-

ability grouping seemed to be the most popular form of classroom organisation in most Kenyan schools.

## **2.4 SUMMARY OF LITERATURE REVIEW**

Research carried out previously outside Kenya has shown that the Individual Learning setting that the pupils were exposed to had a significant effect on their Academic achievement. The studies have also shown that group interaction was a good predictor of high Academic achievement. However, research done in Kenya is not sufficient enough to show a significant relationship between Ability, the Learning setting and Academic achievement. Educators using Ability grouping should thus be able to monitor group interaction to understand the impact on achievement and to encourage group experiences that are beneficial for achieving the desired learning objectives.

## **2.5 RESEARCH HYPOTHESES**

The following research hypotheses were generated from the review of literature.

- a) There is a significant relationship of the Learning setting and the scores on Mathematics tests.
- b) There is a significant relationship of Ability and the scores on Mathematics tests.
- c) There is a significant combined relationship between the Learning setting and Ability on the scores on Mathematics tests.
- d) There is a significant combined relationship of the Mathematics Tasks and the Learning setting on the scores on Mathematics tests.

Details of the methodology used in the study are presented in the next chapter.

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.0 INTRODUCTION**

This chapter describes the methodology that was used in the study. This is discussed in seven sections. The first section has details of the research design and description of variables. The second describes the population. The third contains details of the sample and sampling technique. Section four highlights the instruments used in data collection. Section five describes the Learning settings. Section six describes the procedures for data collection. The last section has statements of the null hypotheses and methods used to analyse the data.

#### **3.1 RESEARCH DESIGN**

A factorial research design was used in the study. According to Kerlinger (1986), in a factorial design, the researcher can modify certain factors and observe the effect of those modifications on the variable of interest. In this design, every possible combination of factor levels was observed and therefore the set of factors was completely crossed.

This design enabled the researcher to control for intervening variables such as the learning materials available, teaching and learning effects and pupil Ability. The duration of the study was three weeks during which two new mathematics topics were learnt and tested. This design was therefore used to investigate the relative efficiency of different Learning settings on different Ability levels, when working on new topics. This design was therefore appropriate for partialing out variances due to various factors.

In this study, Factor A was the Learning setting which had two levels; namely the Individual Learning setting and the Group Learning setting . Factor B was the pupils Ability Levels, and these were high-ability, medium-ability and low-ability levels. Factor C was the Mathematics Tasks. It also had two levels which were Task 1 (Algebra) and Task 2 (Logarithms and Indices). The dependent variables were the error scores on either the Algebra test or the Logarithms and Indices test.

### **3.2 POPULATION**

The population of the study consisted of Form Three boys from a government urban secondary school. This school was used because it is a large secondary school in Kenya. The population was therefore large and this enabled the pupils to be easily sampled. It was a school that streamed pupils according to Ability as determined by end-of-year examination results. Total scores on the K.C.P.E. examination were used to place the pupils in the six streams in Form One. The end-of- year examination results were used to place the pupils in the six Form Two and six Form Three streams. This resulted in a yearly change in the composition of streams in the school. That is, the top forty pupils with the highest aggregate scores were placed in the 3A stream. The next forty pupils were placed in the 3B stream. This procedure was followed until all the six streams were filled. The pupils with the lowest scores were placed in the 3F stream. The population of the study consisted of 240 Form Three pupils of the year 2000.

### **3.3 SAMPLE AND SAMPLING TECHNIQUE**

A total of forty-eight Form Three pupils were selected to take part in the study. A stratified random sampling technique was used to select the sample from a pool of 240 pupils. The stratifying criterion used was based on the pupils' classification as per stream, determined by previous year's examination results. A balanced sample was therefore drawn as shown in Table 3.1 below.

Table 3.1 shows how a stratified random sample was selected with an equal number of pupils from four of the six streams. Twelve pupils were randomly selected from the 3A stream and classified as the high-ability group. The medium-ability group was represented by pupils randomly selected from the 3C and 3D streams while the low-ability group was represented by pupils from the 3F stream. No pupils were selected

from the 3B and 3 E streams. The actual selection was done by putting names of all the pupils in each class, in a box and picking twelve of them at random.

**Table 3.1 Pupil sample by stream**

STREAM	NO IN CLASS	NO. IN SAMPLE
3A	40	12
3B	40	0
3C	40	12
3D	40	12
3E	40	0
3F	40	12
<b>TOTAL</b>	<b>240</b>	<b>48</b>

The pupils in the sample were randomly assigned to twelve groups. Each group consisted of one high-ability pupil, two medium-ability pupils and one low-ability pupil. The actual assignment was also done by putting all the selected names in four different boxes and picking one from each box and assigning them to each group. The composition of the twelve groups is described in Table 3.2 below.

**Table 3.2 Sample distribution by Ability and Groups**

Ability	GROUPS												Total
	A	B	C	D	E	F	G	H	I	J	K	L	
High	1	1	1	1	1	1	1	1	1	1	1	1	12
Medium	2	2	2	2	2	2	2	2	2	2	2	2	24
Low	1	1	1	1	1	1	1	1	1	1	1	1	12
<b>Total</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>4</b>	<b>48</b>

Each group was then randomly assigned to either Block A or Block B each consisting of six groups. The actual assigning was done by putting all the twelve groups in a box and picking each group at random and assigning it to a block or the other. Pupils in Block A learnt Task 1 under Individual Learning setting and Task 2 under Group Learning setting. Those in Block B learnt Task 2 under the Individual Learning

setting while Task 1 under the Group Learning setting. This was to ensure that for each task the pupils completed the tasks under both the Learning setting conditions. The Blocks lasted the entire three weeks that the study took place. The total number of pupils in each Block was therefore 24 (6 groups). Over the entire period of the study none of the pupils in the sample dropped out of the study.

### **3.4 INSTRUMENTATION**

This section describes three instruments used for the purpose of data collection. These instruments were; Mathematics achievement tests, an Observation checklist, and a pupils' Questionnaire. Finally the section contains a description of the Learning materials developed for the study.

#### **3.4.1 Mathematics Achievement Tests.**

Two Mathematics achievement tests were used in the study. One test consisted of complex questions on Algebra while the other consisted of complex questions on Logarithms and Indices. Copies of the tests are in Appendix A. Each of the test was scored on a 0 - 10 point scale with each question carrying five marks. The total error score was determined by counting the number of errors made by each pupil.

The errors made on the tests were classified as;(i) errors specific to the algorithm for carrying out the task, and (ii) computational or algebraic errors not specific to the algorithm. An algorithmic error was made by taking an incorrect step or by using a wrong formula or a wrong guideline for arriving at the solution. For example, on Logarithms and Indices, test, a pupil who interpreted  $8^{2/3}$  as  $8 \times 2/3$  made an algorithmic error. The error was the incorrect application of the rule by changing the power to a number to be multiplied by the base 8. A computational or algebraic error was unrelated to the steps required in setting up or carrying out the algorithm. An example of such an error was evaluating  $8 \times 2/3$  as  $3/16$ . Here clearly the divisor and quotient were switched, or  $(3)^2 = 6$ . The error here was that the base was multiplied by 2 instead of being squared to get 9. It was therefore possible that the computational or algebraic errors resulted from carelessness rather than lack of understanding or knowledge.

On each item, the error score was divided into algorithmic Errors and computational or algebraic Errors. On the Algebra test there was a maximum of four

algorithmic error scores and six computational or algebraic errors scores. The total error score on this test was therefore 10. On the Logarithms and Indices test, the maximum algorithmic error score was five and the maximum computational error score was also five. The total error score was also therefore 10. The different kinds of error scores and the total error scores on each task were used for descriptive analysis while only the total error scores were used for hypotheses testing.

The tests were initially pre-tested with pupils from a parallel secondary school with the one in the study. Details of pretesting are in Appendix E.

### **3.4.2 Observation Checklist**

An Observation checklist was used to collect data on the nature of interaction initiated by each pupil. The observation categories related to algorithmic errors and to computational or algebraic errors. Details of the categories are in Appendix B. The observation data was coded by counting the number of times pupils of different Abilities initiated each kind of interaction. The observation data was not task specific and was analysed by comparing the number of times pupils of different Abilities initiated each kind of interaction.

The frequency of the kind of interaction initiated by each pupil in the group was recorded for each pupil. Trained research assistants familiar with the Mathematics Tasks were used as observers. The Observation Checklist was pre-tested with pupils from a parallel secondary school to enhance its validity and reliability. For details, see Appendix E.

### **3.4.3 Pupils Questionnaire**

A Questionnaire was designed to collect the following information from the subjects.

- (a) The pupils' personal experience when working individually or when working in the Group Learning setting.
- (b) The pupils' opinion of which method of allocating pupils to classes they preferred.
- (c) The pupils' interaction with their classmates and pupils from other classes.

The items on the Questionnaire were structured and the pupils completed the Questionnaire by ticking whichever question they agreed or disagreed with. The pupils took approximately thirty minutes to complete the Questionnaire.

Prior to the main study, the Questionnaire was also pre-tested with students from a parallel secondary school to enhance its validity and reliability. For details see Appendix E. The items on the Questionnaire were structured (closed ended). The Questionnaire had 17 items. Items 1-5 solicited pupils' opinions about the experiences they encountered when working both in the Individual Learning and the Group Learning settings. Items 6-8 asked for the pupils' opinions on which setting they felt was favourable to them. Items 9-14 investigated the patterns of interaction of the pupils with their classmates and with members from other classes. Lastly Items 15-17 were designed to tap pupils' opinion on which system of assigning pupils to classes they preferred. The pupils' responses were content analysed.

#### **3.4.4 Learning Materials**

This consisted of Kenya Institute of Education Form Three Mathematics Instructional booklets, their answer booklets, a package of complex questions and a package of stepwise solutions to the complex questions, prepared by the instructor. For details see Appendix D. The K.I.E. instructional booklets contained simple examples expressing basic concepts on the tasks that were given. For each basic example, there was a step-by-step solution to the question. After the examples, there were some sample exercises whose solutions were found in the answer booklets accompanying the instructional booklets. The package of complex questions consisted of complex questions on Task 1 (Algebra) and complex questions on Task 2 (Logarithms and Indices). The complex questions were the same format as those taken in the final test. The package of the solutions of the complex questions consisted of step-by-step solutions for each task. The solutions in co-operated the basic concepts that were in the instructional booklets.

### **3.5 LEARNING SETTINGS**

Two kinds of Learning settings were used. These were the Individual Learning setting and Group Learning setting.

### **3.5.1 Individual Learning Setting**

The instructor gave all the subjects the Learning materials described above and they were shown how to use them to solve basic questions. The pupils worked alone on the Learning materials and only consulted with the instructor after studying all the hints. They also checked their answers with those of the instructor. In this setting, there were five one and half hour sessions through which the pupils learnt the basic concepts. A further three one half hour sessions was used to work through the complex questions.

### **3.5.2 Mixed Ability Group Learning Setting**

The pupils worked in groups of four and also had all the Learning materials described earlier. The instructor showed them how to solve basic questions, by helping each other to ensure that every member of the group had understood how to solve the basic questions. The pupils were instructed to ask questions of group mates and to explain how to solve the questions to any member who was confused. The pupils were shown how to state the objectives of the task, direct the group work and delegate work. They were also told to solicit for explanations from each other in case of difficulties. This setting also had five, one and half-hour sessions through which the pupils learnt the basic concepts. There were further three sessions of one and half-hours through which the pupils worked on the complex questions.

## **3.6 DATA COLLECTION PROCEDURE**

In the last group sessions, an observer in each group noted the nature of interaction initiated by each pupil. After the last learning sessions the pupils took two tests. The tests were administered under power conditions. This meant that no timing was made to enable all the pupils to complete the tests. The tests were administered under examination conditions. The pupils sat for the tests alone and no consultation was allowed. They also made no reference to the Learning materials that they initially had. The whole testing session took approximately two hours.

After completing the tests, the pupils completed the pupils' Questionnaire. They were given ample time to respond to all the items on the Questionnaire. The study took place within the first term of the school year.

### 3.6 DATA ANALYSIS

The tests were scored, coded and entered for further analysis. The data was analysed using the Statistical Package for Social Sciences (SPSS) (Nie et al, 1975).

Descriptive statistics such as percentages and measures of central tendency such as the mean, were used to describe the incidence of errors on the tests in the Individual and Group setting; and the mean error scores for Ability and the Learning settings on both Task 1 on Algebra and Task 2 on Logarithms and Indices.

Two-way factorial Analysis of Variance was used in the hypotheses testing. ANOVA uses the concept of F-distribution. This sampling distribution was used to test hypotheses about two or more population variance and the interaction between one variable and the other. The most common use of the F-ratio is testing hypotheses regarding equality of two or more population means.

Two-way factorial ANOVA was therefore used to test if there were significant differences between the mean error scores of high, medium and low-ability pupils; the Individual Learning setting and the Group Learning setting; Task 1 on Algebra and Task 2 on Logarithms and Indices. It was also used to test the interaction of Ability and the Learning setting; and also used to test the interaction of the Mathematics Tasks and the Learning setting. The level of significance used was 0.05 with 1, 42 degrees of freedom for the Learning setting alone, 2, 42 degrees of freedom for Ability alone and 1, 42 degrees of freedom for the interaction of Ability and the Learning setting in each of the two tasks. There were also 1, 20 degrees of freedom for the main and interaction effects of the Mathematics Tasks and the Learning settings for the high and low-ability levels and 1,44 degrees of freedom for the medium-ability pupils. The dependent measures were the total error scores on the Algebra test and the total error scores on the Logarithms and Indices test.

The F-ratio in two-way ANOVA provided a test of null hypotheses that two or more population means were equal. Post-hoc Tukey-statistic was used to compare the difference among the means where the difference was statistically significant.

The following null hypotheses were tested: -

- a) There was no significant effect of the Learning Setting on the total error scores on Task I (Algebra) and Task2 (Logarithms and Indices.)
- b) There was no significant effect of Ability on the total error scores on Task 1(Algebra) and Task 2(Logarithms and Indices.)

- c) There was no significant combined effect of the Learning setting and Ability on the total error scores, on Task 1 ( Algebra) and Task 2 (Logarithms and Indices)
- d) There was no significant combined effect of the Mathematics Tasks and the Learning Setting on the total error scores for each of the three Ability levels.

### 3.7.1 Observation Data

An analysis of the nature of interaction of the pupils and their experiences in the Group Setting was conducted to explain the performance at each Ability level. Group interaction was analysed separately for content related to (1) the algorithms, and (2) computational or algebraic manipulations. A table was developed to show the number of instances of interaction initiated by each pupil for all the three Ability levels. An analysis of the relationship between the type of interaction initiated by each pupil and the Ability level was therefore made.

The results and discussion are presented in the next chapter

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSION**

#### **4.0 INTRODUCTION**

This chapter presents the findings of the study. The chapter is divided into five sections. Section one presents the descriptive analysis of the test performance. Section two discusses the results of hypotheses testing on the relationship between the Learning settings, Ability and the Mathematics Tasks. Section three gives the discussion of findings. Section four deals with the secondary analysis. This is presented in two sub-sections. The observation data; and the questionnaire response. In the last section a summary of the results is presented along with the conclusions drawn from the findings.

#### **4.1 DESCRIPTIVE ANALYSIS OF TEST PERFORMANCE**

This section analyses the test performance of the pupils and more specifically looks at the performance by Error type on Task 1 (Algebra) and Task 2 (Logarithms and Indices). Table 4.1 summarizes the error scores on Task 1 (Algebra) in the Individual and Group Learning settings. Since the number of errors of the two categories differed across the items, percentages were used to allow direct comparisons across the categories.

Table 4.1 presents the error scores by Ability and the Learning settings for Task 1 (Algebra). The columns represent the raw and percentage error scores at each ability level while the rows represent the Error type. The last two columns show that total errors made in the Group setting (62.1%) were less than those made in the

**Table 4.1. Error scores on Task 1 (Algebra) in the Individual and Group Learning settings.**

<b>Individual Learning Setting</b>								
	<b>High-Ability (N=6)</b>		<b>Medium-Ability (N=12)</b>		<b>Low-Ability (N=6)</b>		<b>All Pupils (N=24)</b>	
<b>Error Score</b>	Raw	%	Raw	%	Raw	%	Raw	%
<b>Algorithmic</b>	8	33.3	37	77.0	16	66.7	61	63.5
<b>Algebraic</b>	26	72.2	58	80.5	30	83.3	114	79.2
<b>Total</b>	<b>34</b>	<b>56.7</b>	<b>95</b>	<b>79.2</b>	<b>46</b>	<b>76.7</b>	<b>175</b>	<b>72.9</b>
<b>Group Learning Setting</b>								
	<b>High-Ability (N=6)</b>		<b>Medium-Ability (N=12)</b>		<b>Low-Ability (N=6)</b>		<b>All Pupils (N=24)</b>	
<b>Error Score</b>	Raw	%	Raw	%	Raw	%	Raw	%
<b>Algorithmic</b>	5	20.8	32	66.7	9	37.5	46	47.9
<b>Algebraic</b>	26	72.2	56	77.8	21	58.3	103	71.5
<b>Total</b>	<b>31</b>	<b>51.7</b>	<b>88</b>	<b>73.3</b>	<b>30</b>	<b>50.0</b>	<b>149</b>	<b>62.1</b>

Individual setting (72.9%). The Group setting therefore appeared to reduce the total error scores of all the pupils compared to the Individual Learning setting. The total error scores at each Ability level however differed across Learning settings

In the Individual Learning setting, the high-ability pupils made the least total errors (56.7%), the low-ability pupils made most errors (76.7%) while the medium-ability pupils made more of the total errors (79.2%). The Group setting appeared to reduce the total error scores of all the pupils. The greatest reduction was for the low-ability pupils (50%). There were only slight reductions in the total error scores for the high-ability pupils (51.7%) and medium-ability pupils (73.3%) over the Individual setting. The Group setting therefore appeared to reduce the total error scores of pupils from all Ability levels with a tremendous reduction noted for the low-ability pupils.

When the error types were distinguished, it can be seen from Table 4.1 in the last column, that all pupils made more algorithmic errors (63.5%) in the Individual setting than they did in the Group setting (47.9%). All pupils also made more algebraic errors in the Individual setting (79.2%) than in the Group setting (71.5%).

This showed that the Group setting appeared to reduce the error scores of each kind over the Individual setting. Considering each Ability level, high-ability pupils made more algorithmic errors in the Individual setting (33.3%) than they did in groups (20.8%). They however made the same algebraic errors in the Individual setting as the Group setting (72.2%). The medium-ability pupils on the other hand made fewer algorithmic errors in the Group setting (66.7%) than under the Individual setting (80.5%). The low-ability pupils also made fewer algorithmic errors in the Group setting (37.5%) than in the Individual setting (66.7%) and also fewer algebraic errors in the Group setting (58.3%) than the Individual setting (83.3%)

The Group setting therefore seemed to help high-ability pupils learn the algorithms but did not have any effect on the algebraic manipulations. The Group setting also appeared to help medium-ability pupils learn the algorithms and also made them more careful when computing operations. The Group setting seemed to help most of the low-ability pupils learn the algorithms and also made them more careful when computing operations. It was therefore seen that the Group setting was good for the medium and low-ability pupils on all counts.

Table 4.2 shows the error scores for Task 2 (Logarithms and Indices) in the Individual and Group Learning settings. The bottom row of Table 4.2 shows the error scores without differentiating by error type. The last two columns showed that the total error scores in the Individual setting (51.25%) were slightly less than the total error scores in the Group setting (54.6%) for all the pupils. The total error scores at each Ability level however differed across Learning settings. In the Individual Learning setting, high-ability pupils made the least total error scores (18.3%), medium-ability pupils made the most (63.3%) while the low-ability pupils made more errors (60.0%). The Group setting appeared to reduce the total error scores for the medium-ability pupils but increased them for the high and low-ability pupils. High and low- ability pupils therefore made more errors learning in groups than they did learning individually.

When the error types were distinguished, it was seen that high-ability pupils made more algorithmic errors when working in groups (23.3%) than when working individually (13.3%). They made more computational errors when working in the Group setting (30.0%) than when working in the Individual setting (23.3%). The medium-ability pupils on the other hand made more algorithmic errors in the Group

**Table 4.2 Error scores on Task 2 (Logarithms and Indices) in the Individual and Group Learning settings.**

<b>Individual Learning Setting</b>								
	<b>High-Ability (N=6)</b>		<b>Medium-Ability (N=12)</b>		<b>Low-Ability (N=6)</b>		<b>All Pupils (N=24)</b>	
<b>Error Score</b>	Raw	%	Raw	%	Raw	%	Raw	%
<b>Algorithmic</b>	4	13.3	26	43.3	15	50.0	45	37.5
<b>Computational</b>	7	23.3	50	83.3	21	70.0	78	65.0
<b>Total</b>	<b>11</b>	<b>18.3</b>	<b>76</b>	<b>63.3</b>	<b>36</b>	<b>60.0</b>	<b>123</b>	<b>51.25</b>
<b>Group Learning Setting</b>								
	<b>High-Ability (N=6)</b>		<b>Medium-Ability (N=12)</b>		<b>Low-Ability (N=6)</b>		<b>All Pupils (N=24)</b>	
<b>Error Score</b>	Raw	%	Raw	%	Raw	%	Raw	%
<b>Algorithmic</b>	7	23.3	28	46.7	22	73.3	57	47.5
<b>Computational</b>	9	30.0	45	75.0	20	66.7	74	61.7
<b>Total</b>	<b>16</b>	<b>26.7</b>	<b>73</b>	<b>60.8</b>	<b>42</b>	<b>70.0</b>	<b>131</b>	<b>54.6</b>

setting than the Individual setting but made fewer computational errors in the Group setting over the Individual setting. The low-ability pupils made fewer algorithmic errors in the Individual setting (50%) than in the Group setting (73.3%), but made more computational errors in the Individual setting (70%) over the Group setting (66.7%). Therefore whether working in groups was interpreted as beneficial or detrimental compared to individual work depended upon the Error type that was emphasized.

The Individual Learning setting seemed to help all the pupils learn the algorithms but appeared to make the medium and low-ability pupils make more errors when doing computations. The Group setting however appeared to make the medium and low-ability pupils make few errors when manipulating operations (computations).

When the performance on the two tasks was compared, it was seen that the total error scores in both settings on Task 2 (Logarithms and Indices) were fewer than

the total error scores on Task 1 (Algebra). It was therefore generally seen that the total test performance on Logarithms and Indices was better than that on Algebra.

#### 4.1.1 MEAN ERROR SCORES FOR EACH ABILITY LEVEL IN THE LEARNING SETTINGS.

The mean error scores at each Ability level were determined in both the Individual and Group Learning settings. This was for both Task 1 (Algebra) and Task 2 (Logarithms and Indices). Table 4.3 shows the mean error scores on Task 1 (Algebra) test for Ability and the Learning settings.

**Table 4.3. Mean error scores on Task 1 (Algebra), for various Ability Groups and the Learning Settings.**

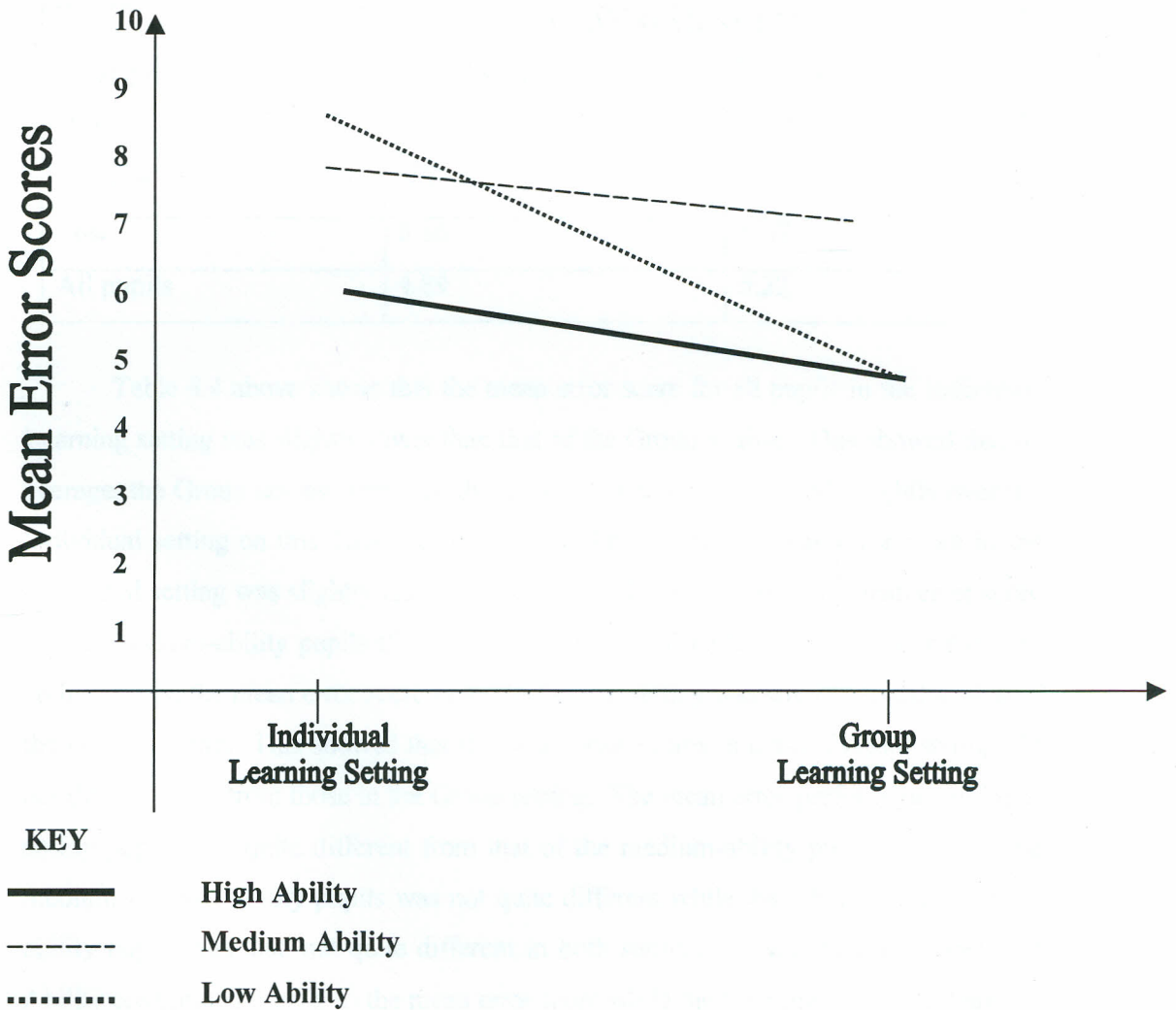
ABILITY	LEARNING SETTINGS	
	Individual	Group
High	5.67	5.00
Medium	7.92	7.33
Low	8.33	5.00
All pupils	7.31	5.77

It can be seen from Table 4.3 that the mean error score for all pupils in the Individual Learning setting was higher than the mean error score in the Group setting. This indicated that on average, the Group setting significantly reduced the mean error scores over the Individual Learning setting. It was however seen from Table 4.3 that the Group setting tremendously reduced the mean error scores of the low-ability pupils over the Individual Learning setting. The Group setting however reduced only slightly the mean error scores for the high and medium-ability pupils. This indicated that the low-ability pupils highly benefited from the Group Learning setting.

In the Individual Learning setting, the mean error score for the high-ability pupils was quite different from that of the medium-ability pupils and also from that of the low-ability pupils. The mean error scores of the medium and low-ability pupils did not differ greatly. In the Group setting however, the mean error scores of the high-ability and low-ability pupils did not differ. The mean error score for the high-ability and low-ability

pupils did not differ greatly from those of medium-ability pupils. It was seen that Ability contributed greatly to variations in the mean error scores while the Learning setting appeared to contribute greatly to the mean error scores only for the low-ability pupils. Figure 4.1 shows a graph of the mean Error scores for Ability and the Learning settings.

**Figure 4.1. Graph of the mean Error scores of the combination of Ability and the Learning Settings on Task 1 (Algebra).**



It is seen from Figure 4.1 that the Group setting reduced the mean error scores over the Individual Learning setting for pupils in all the Ability levels. A tremendous reduction can be seen for the low-ability pupils. It can also be seen from Figure 4.1 that, the lines for medium-ability and low-ability pupils and also those for the high-ability and

low-ability intersect. The lines for the high and medium-ability pupils do not however meet. This suggests a likelihood of a combined effect of Ability and the Learning setting on the total error scores. The low-ability pupils therefore seemed to greatly benefit from the Group setting. Table 4.4 shows the mean error scores on Task 2 (Logarithms and Indices) for Ability and Learning settings.

**Table 4.4. Mean error scores on Task 2 (Logarithms and Indices) for Ability and the Learning settings.**

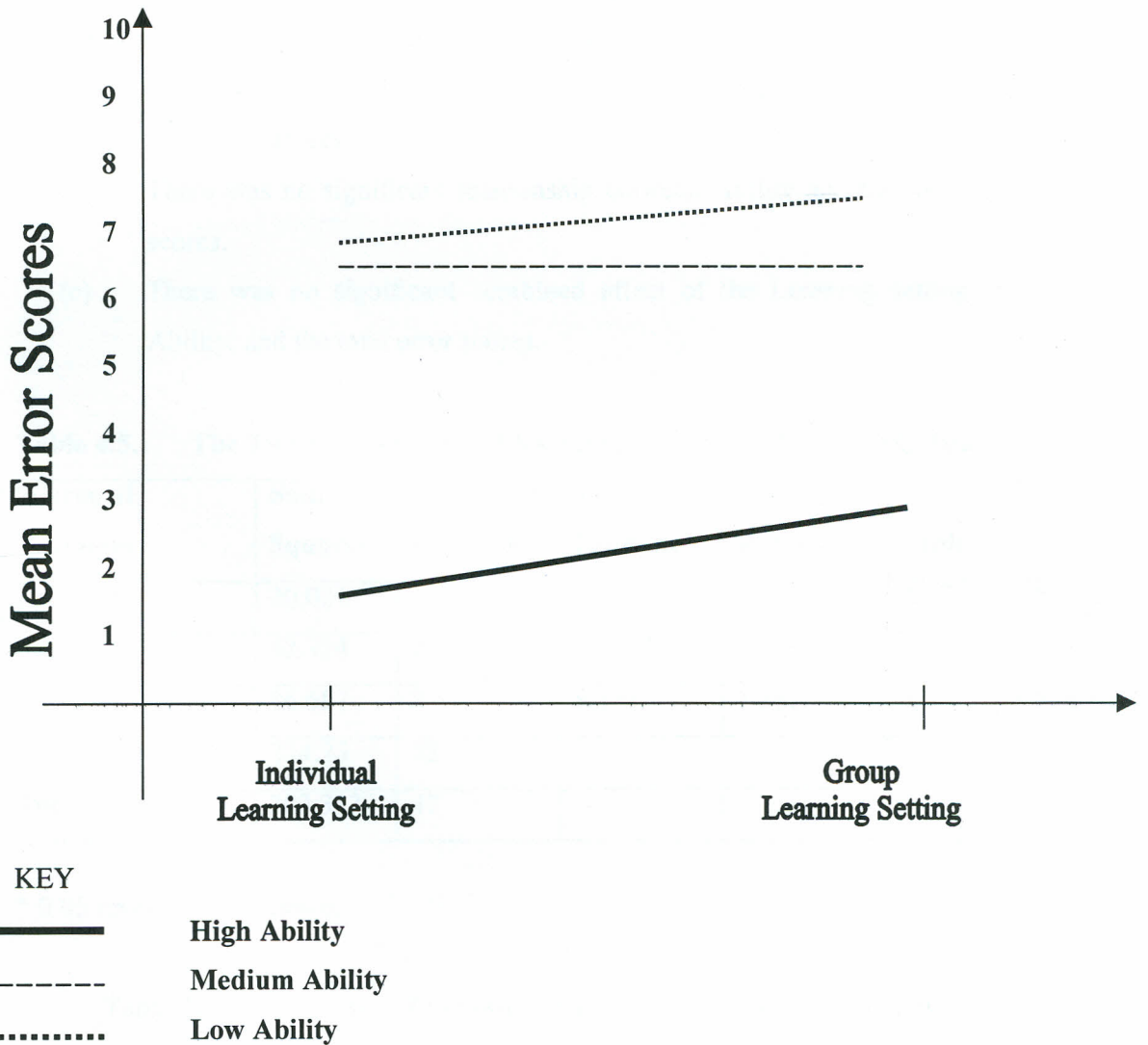
	LEARNING SETTINGS	
ABILITY	Individual	Group
High	1.83	2.67
Medium	6.33	6.33
Low	6.50	6.67
All pupils	4.89	5.22

Table 4.4 above shows that the mean error score for all pupils in the Individual Learning setting was slightly lower than that of the Group setting. This showed that on average, the Group setting increased the mean error score of all pupils slightly over the Individual setting on this Task. For the high-ability pupils the mean error score in the Individual setting was slightly less than that in the Group setting. The mean error score for the medium-ability pupils did not differ in either of the two settings. For the low-ability pupils, the mean error score in the Individual setting was slightly less than that of the Group setting. This showed that the mean error scores in the Individual setting did not differ greatly from those in the Group setting. The mean error performance of high-ability pupils was quite different from that of the medium-ability pupils. That of the medium and low-ability pupils was not quite different while that of the high and low-ability pupils was also not quite different in both settings. It was therefore seen that Ability contributed greatly to the mean error score while the Learning setting did not.

Figure 4.2 shows a graph of the mean error scores for Ability and the Learning setting on Task 2 (Logarithms and Indices). Figure 4.2 above shows that the Group setting slightly increased the mean error scores of the pupils over the Individual setting for both the high and low-ability pupils. The Learning setting had no effect on the mean error scores for the medium-ability pupils. It can be seen that the lines do not cross each

other. The graph suggests that the Individual Learning setting was better than the Group setting in reducing the mean error scores for the high and low-ability pupils. High-ability pupils therefore generally benefited from the Individual Learning setting. As can also be seen in both the settings, the high-ability pupils made the least errors, the medium-ability pupils made more errors while the low-ability pupils made the most errors

**Figure 4.2.** Graph of the mean error scores of the combination of Ability and the Learning Settings for Task 2 (Logarithms and Indices).



These findings suggest that Ability played a great role in the mean error scores of the pupils, while the Learning setting did not.

Comparing the mean error scores of all pupils in the Individual Learning setting on Task 1 and Task 2, from Table 4.3 and Table 4.4, it appeared that fewer errors were made in Task 2 than on Task 1. In the Group setting however, the mean error scores for all pupils on Task 1 was not quite different from that on Task 2.

#### 4.2 RELATIONSHIP BETWEEN THE LEARNING SETTING AND ABILITY

The following null hypotheses were tested in order to investigate the main and interaction effects of Ability and the Learning setting on the total error scores on Task 1 (Algebra) and on Task 2 (Logarithms and Indices).

- (a) There was no significant relationship between the Learning setting and the total error scores.
- (b) There was no significant relationship between Ability and the total error scores.
- (c) There was no significant combined effect of the Learning setting and Ability, and the total error scores.

**Table 4.5. The Two-way Analysis of Variance (N=48) for Task 1 (Algebra).**

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	F Prob.	
Factor A	20.021	1	20.021	3.749	4.07	Not Sig.
Factor B	42.354	2	21.177	3.966*	3.22	Sig
A X B	16.687	2	8.344	1.562	3.22	Not Sig
Within group (error)	224.25	42				
Total	303.313	47				

\* 0.05 level of significance.

Table 4.5 shows results of two-way Analysis of Variance. A level of 0.05 of significance was used to test the above hypotheses on Algebra. Table 4.5 shows that Factor A (Learning setting) had no significant effect, Factor B (Ability) had a significant effect and the interaction of Factor A and Factor B was not significant at

$P < .05$ . The findings failed to reject the null hypotheses of no significant effect of the Learning setting and no significant combined effect of the Learning setting and Ability on the total error scores, at 0.05 level of significance. However the null hypothesis of no significant effect of Ability on the total error scores, was rejected at 0.05 level of significance. The alternative hypothesis of a significant relationship between Factor B (Ability) and the total error scores was accepted at 0.05 level of significance.

From Table 4.5, it was evident that the Learning setting did not have a significant effect on the pupils' performance on Algebra. The obtained F-value of 3.749 was less than the table value of 4.07 with 1,42 degrees of freedom. Therefore whether the pupils were in the Individual setting or in the Group setting did not have a significant effect on their total error scores.

It was also evident that Ability did have a significant effect on the total error scores. The obtained F-value of 3.966 was greater than the table value of 3.22 with

**Table 4.6 Post-Hoc Tukey comparison of the Ability levels on Task 1**

Ability	Mean Error Score	Difference	Tukey Value
High	5.335	2.29*	1.906
Medium	7.625	1.33	1.906
Low	6.665	0.96	1.906

\*0.05 level of significance.

2,42 degrees of freedom. Table 4.6 shows the results of Post-Hoc comparison using Tukey test statistic.

Table 4.6 shows that the absolute value of 2.29 of the difference between the mean error scores of high and medium-ability pupils was more than the Tukey table value of 1.906 and was therefore statistically significant at  $P < .05$ . The mean error score for the high-ability pupils was thus significantly lower than the mean error score for the medium-ability pupils.

For the difference between the mean error scores for the medium and low-ability pupils the absolute value of 0.96 and was less than the Tukey value of 1.906

and was therefore not statistically significant. For the difference between the high and low-ability pupils, the absolute value of 1.33 was less than the Tukey value of 1.906. The difference in the mean error scores was not therefore statistically significant.

From this result, the Learning setting accounted for 4.76% of the variance in the total error scores while Ability accounted for 10.26%. The combination of both the Learning setting and Ability accounted for 1.95% of the variance in the total error scores. Therefore a strong association existed between Ability and the total error scores. The other proportion of error scores could have been accounted for by other factors, which will be described later.

**Table 4.7 Two-way Analysis of variance (N=48) for Task 2 (Logarithms and Indices)**

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	F Prob	
Factor A	0.75	1	0.75	0.13	4.07	Not Sig
Factor B	156.75	2	78.375	13.58*	3.22	Sig
A X B	1.417	2	0.736	0.128	3.22	Not Sig
Within group (error)	242.33	42				
Total	401.25	47				

\*0.05 level of significance.

Table 4.7 shows results of two-way Analysis of Variance on Task 2 (Logarithms and Indices). A level of 0.05 of significance was used to test the above hypotheses.

Table 4.7 shows that Factor A (Learning setting) had no significant effect, Factor B (Ability) had a significant effect and the interaction effect of Factor A and Factor B was not significant at  $P < .05$ . The findings failed to reject the null hypotheses of no significant effect of the Learning setting and no significant combined effect of the Learning setting and Ability on the total error scores, at 0.05 level of significance. However the null hypothesis of no significant effect of Ability on the total error scores was rejected at 0.05 level of significance.

It was therefore evident from the Table 4.7 that the Learning setting did not have any significant effect on the pupils' error scores. The obtained F-value of 0.13 was less than the table value of 4.07 with 1,42 degrees of freedom. Here again when the pupils were placed in either of the two settings, it did not have any significant effect on their total error scores.

Table 4.7 shows that Ability did have a significant effect on the total error scores. The obtained F-value of 13.58 was greater than the table value of 3.22 with 2,42 degrees of freedom. Table 4.8 shows the results of post-hoc comparison using Tukey test statistic.

**Table 4.8. Post-Hoc Tukey comparison of the Ability levels on Task 2.**

Ability	Mean Error Score	Difference	Tukey Value
High	2.25	4.08*	1.982
Medium	6.33	4.335*	1.982
Low	6.585	0.255	1.982

\* 0.05 level of significance.

Table 4.8 shows that the absolute value of 4.08 of the difference between the mean error scores of the high and medium-ability pupils was more than the Tukey value of 1.982 and was therefore statistically significant at  $P < .05$ . The absolute value of 0.255 of the difference between the mean error scores of the medium and low-ability pupils was less than the Tukey table value of 1.982 and was therefore not statistically significant at  $P < .05$ .

Table 4.7 also shows that the interaction effect of the Learning setting and Ability was not significant at  $P < .05$ . The obtained F-value of 0.128 was less than the table value of 3.22 with 2,42 degrees of freedom. There was therefore no combined effect of the Learning setting and Ability on the total error scores of the pupils.

From this study, Ability accounted for 35.7% of the variance in the total error score while the Learning setting and the combination of Ability and the Learning setting accounted to a very small extent to the variance in the total error scores. Therefore a strong association existed between Ability and the total error scores. The association was quite sizable in a predictive sense for any population corresponding to

the current study. The other proportion of variance could have been accounted for by other factors that will be described later.

### 4.2.1 Relationship between the Learning Setting and Mathematics Tasks

The following null hypotheses were tested in order to investigate the main effect of the Mathematics Tasks and the interaction effect of the Mathematics Tasks and the Learning setting for pupils in the three Ability levels.

- (d) There was no significant relationship between the Mathematics Tasks and the total error scores.
- (e) There was no significant combined relationship of the Learning settings and the Mathematics Tasks, and the total error scores.

Table 4.9 shows results of two-way Analysis of Variance. A level of 0.05 of significance was used to test the above hypotheses for High-ability pupils.

**Table 4.9. The Two-way Analysis of Variance (N=24) for High-ability pupils.**

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	F Prob	
Factor A	0.042	1	0.042	0.007	4.35	Not Sig
Factor C	57.042	1	57.042	10.232*	4.35	Sig
A X C	3.375	1	3.375	0.605	4.35	Not Sig
Within group (error)	111.500	20				
Total	171.958	23				

\* 0.05 level of significance.

Table 4.9 shows that Factor C (Mathematics Tasks) was significant and the interaction of Factor A (Learning settings) and Factor C was not significant at  $P < .05$ . The null hypothesis of no significant effect of the mathematics tasks on the total error scores was rejected while that of no significant combined effect of the Learning setting and the Mathematics Tasks on the total error scores was accepted. The

alternative hypothesis of a significant effect of the Mathematics Tasks on the total error scores was accepted at 0.05 level of significance.

From Table 4.9, it was seen that the Mathematics Tasks had a significant effect on the high-ability pupil's performance. The obtained F-value of 10.232 was more than the table value of 4.35 with 1,20 degrees of freedom. Therefore the performance of the high-ability pupils' greatly depended on the Tasks. The mean error score for the high-ability pupils on Algebra (5.335) was significantly higher than the mean error score on Logarithms and Indices (2.25). This showed that high-ability pupils performed better on Logarithms and Indices than on Algebra

From the findings, the Mathematics Tasks accounted for 29% of the variance in the total error scores. It was therefore concluded that a strong association existed between the Mathematics tasks alone and the error scores for high-ability pupils. This association was sizable in a predictive sense for any population that corresponds to the current study.

Table 4.10 shows the results of two-way Analysis of Variance. A level of significance of 0.05 was used to test the above hypothesis for the medium-ability pupils.

**Table 4.10. The Two-way Analysis of Variance (N=48) for Medium-ability pupils.**

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	F Prob	
Factor A	1.021	1	1.021	0.161	4.06	Not Sig
Factor C	20.021	1	20.021	3.158	4.06	Not Sig
A X C	1.021	1	1.021	0.161	4.06	Not Sig
Within group (error)	278.92	44				
Total	300.98	47				

Table 4.10 shows that Factor C (Mathematics Tasks) and the interaction of Factor A (Learning Settings) and Factor C was not significant at  $P < .05$ . The null hypothesis of no significant effect of the Mathematics Tasks on the total error scores and that of no significant combined effect of the Learning Setting and the

Mathematics Tasks on the total error scores were accepted. It was seen from Table 4.10 that the Mathematics Tasks had no significant effect on the medium-ability pupils' performance. The obtained F-value of 3.158 was less than the table value of 4.06. The performance of the medium-ability pupils did not depend on the tasks. The mean error scores on Task 1 were not significantly different from those of Task 2.

From Table 4.10 it can also be seen that there was no significant interaction effect of the Learning setting and the Mathematics Tasks for medium-ability pupils at  $P < .05$ . The obtained F-value of 0.161 was less than the table value of 4.06.

From this finding, the Mathematics Tasks alone accounted for 4.45% of the variance in the total error scores for the medium-ability pupils. A weak association was therefore seen between the Mathematics Tasks and the total error scores. This association was not sizeable in a predictive sense for any population that corresponds to this study.

Table 4.11 shows the results of two-way Analysis of Variance. A level of significance of 0.05 was used to test the above hypotheses for the low-ability pupils.

**Table 4.11 The Two-way Analysis of Variance (N=24) for Low-ability pupils.**

Source of Variation	Sum of Squares	Degrees of Freedom	Variance Estimate	F Ratio	F Prob	
Factor A	15.042	1	15.042	3.949	4.35	Not Sig
Factor C	0.042	1	0.042	0.011	4.35	Not Sig
A X C	18.374	1	18.374	4.825*	4.35	Sig
Within group (error)	76.167	20				
Total	109.625	23				

\* 0.05 level of significance.

Table 4.11 shows that Factor C was not significant and the interaction of Factor A and Factor C was significant at  $P < .05$ . The null hypothesis of no significant effect of the Mathematics Tasks and the total error scores was accepted while that of no significant combined effect of the Learning setting and the Mathematics Tasks on the total error scores was rejected. The alternative hypothesis of a significant interaction effect of the Learning setting and the Mathematics Tasks was accepted. It

was thus seen that the Mathematics Tasks had no significant effect on the total error scores of the pupils. The obtained F-value of 0.011 was less than the table value of 4.35 with 1,20 degrees of freedom. The performance of the low-ability pupils did not therefore depend on the tasks. The mean error scores on Task 1 were not significantly different from the mean error scores of Task 2.

Table 4.11 also shows that there is a significant interaction effect of the Learning setting and the Mathematics Tasks for low-ability pupils at  $P < .05$ . The obtained F-value of 4.825 was more than the table value of 4.35 with 1,20 degrees of freedom. The performance of the low-ability pupils therefore greatly depended on the combination of the Tasks and the Learning setting. On one Task, the Group setting appeared to reduce the mean error score of the low-ability pupils while on another Task, the Individual setting appeared to reduce slightly the mean error scores over the Group setting. The Group setting therefore significantly reduced the mean error scores of the low-ability pupils and was quite beneficial to the achievement on Task 1 (Algebra). The Individual setting however appeared to be slightly beneficial to achievement on Task 2 over the Group setting. It was therefore concluded that whether the Learning setting was beneficial to the low-ability pupils greatly depended on the tasks that were used.

From these findings the combination of the Mathematics Tasks and the Learning setting accounted for 12.84% of the variance in the total error scores, while the Mathematics Tasks alone accounted for 9.9% of the variance in the total error scores. In each of the associations described previously, the unexplained variance could have been attributed to factors, which were not considered in this study. The possible factors that could have contributed to the unexplained variance were suggested to be:

- a) The level of interest and attitude the pupils had in Mathematics. It was possible that some had a negative attitude towards the subject.
- b) The pupils' personality might have also affected their contributions in the group discussions. Some pupils might have been introverts while others were extroverts.
- c) The levels of motivation of the pupils during the study. It was possible that some pupils were highly motivated while others were not motivated at all.
- d) The size of the sample used was small and only represented a small fraction of the whole population.

These among others were some of the factors that could account for the unexplained variance and were not considered in this study. It is hoped that a study will be conducted to find out whether this is the case.

### **4.3 DISCUSSION OF FINDINGS**

In summary, analysis of the total test performance indicated that on Task 1, the Group setting seemed to greatly reduce the total error scores for all the pupils over the Individual setting. On Task 2, the Individual setting seemed to only slightly reduce the total error scores of all the pupils over the Group setting. The Group setting also reduced the mean error scores of all the pupils over the Individual setting on Task 1. The greatest reduction was seen for the low-ability pupils. On Task 2, the mean error score in the Individual setting was slightly better than that in the Group setting, but the Individual setting seemed to highly favour the high-ability pupils.

Two-way Analysis of Variance showed that the Learning setting had no significant effect on the total error scores, Ability had a significant effect while the interaction effect of the Learning setting and Ability was not significant at 0.05 level of significance. This finding was noted for both Task 1 and Task 2. Further the Mathematics Tasks had a significant effect on the total error scores for the high-ability but not for the medium and low-ability pupils.

The findings from descriptive data indicated that the Learning setting had some effect on the total error scores, though this was not significant. On Task 1, the Group setting seemed to be better than the Individual setting while on Task 2, the performance in both settings seemed to be the same.

Ability was seen to have a significant effect on the total error scores. The high-ability pupils in both settings did better than the other pupils. However, descriptive analysis showed that the performance of the pupils of different Abilities also depended on the Learning setting. It was found however that the interaction effect of the Learning setting and Ability was not significant. On Task 1 it was seen that all pupils benefited from the Group setting with the low-ability pupils being the greatest beneficiary. On Task 2 the Individual setting seemed to highly benefit the high-ability pupils. It was therefore seen from descriptive data that performance of the pupils from different Ability levels depended on the Learning setting.

Considering the Mathematics Tasks, it was seen from descriptive data that the performance of all the pupils depended on the Tasks. The performance of all the pupils on Task 2 seemed to be better than that on Task 1. Task 2 might have been well understood than Task 1. However considering each Ability level, the performance of high-ability and low-ability pupils on Algebra was the same. The high-ability pupils must have influenced the performance of the low-ability pupils. This was not the case for the medium and low-ability pupils.

The interaction effect of Learning setting and the Mathematics Tasks was significant only for the low-ability pupils but not for the high and medium-ability pupils. From descriptive data, the group setting highly benefited the low-ability pupils on Task 1 while on Task 2, the performance on both settings seemed to be the same.

In summary, the findings from descriptive data seemed to indicate an interaction effect of the Learning setting and Ability, though this was not significant. Further, the performance of the high-ability pupils highly depended on the tasks but not for the medium and low-ability pupils.

The findings of no significant effect of the Learning setting on the total error scores are consistent with previous research carried out in Kenya. Lukhoba (1988) found no relationship between the Learning setting and academic achievement. However, Lukhoba had used test results from two schools that were unstreamed and one that was streamed. Lukhoba also used composite test scores in English, Mathematics and Biology. The study also used chi-square, non-parametric method to arrive at the findings because the population used was not normally distributed as required in parametric methods.

In Europe, Daniels (1961b), Braddock and Slavin (1993) and Donelan and Mayer (1994) have shown differences in attainment scores of pupils in mixed-ability group settings and those in same-ability settings. The pupils in streamed schools were found to have on average, lower mean scores on achievement tests than those in unstreamed schools. In the above studies, no observations were made by putting same pupils in different Learning settings.

Ability was seen to have a significant effect on the total error scores of the pupils. These findings were in agreement with research done in America. Dar and Resh (1986) confirmed that the intellectual dimension of the pupils was the strongest variable that predicted high academic achievement. They used a quasi-experimental

comparison between a heterogeneous class and a homogeneous class of high and low-ability. Their study found that personal Ability level played a decisive role in predicting Academic achievement.

The findings of no significant interaction effect of the Learning setting and Ability are not consistent with previous research done in America. Webb (1980) revealed that low-ability pupils did better in the Group setting than the Individual setting, high-ability pupils did best in the Individual setting, while the medium-ability pupils did the same whether in groups or individually. However descriptive data showed that this was true in the current study. Webb et al (1986) also found out that helping each other was positively related to achievement. The finding was also not consistent with a study by Beane and Lemke (1971) and many other studies on peer tutoring (Lippit and Lippit, 1968; Molland, 1970; Smith, 1977), found that working in mixed-ability groups were advantageous for medium and low-ability pupils but not for high-ability pupils. Their studies found that the effect of the Learning setting depended on the Ability levels of the pupils.

The findings of no significant effect of the Mathematics Tasks was consistent with a study by Webb and Cullian (1983). They used three Tasks on Consumer Mathematics, Area and Perimeter and Probability. They found that the tasks had no effect on mathematics achievement. This however is in contrast to the finding of a significant effect of the Mathematics Tasks for the high-ability pupils. Though this was found to apply to the high-ability pupils, it had no effect on the medium and low-ability pupils.

The findings of the study, lead to the conclusion that the Learning setting had no significant effect on the total error scores. However, descriptive data indicated that the Learning setting had an effect on the pupils performance though not significant. Ability was found to have significant effect on the total error scores. As expected pupils of high-ability made few errors while those of low-ability made significantly more errors on both tasks. The interaction effect of Ability and Learning setting was not significant. The performance of the pupils from various Ability levels did not depend on the Learning settings. However descriptive analysis and graphs showed that the low-ability pupils performance was better in the Group setting than in the Individual setting.

From the findings of the study it was concluded that the Learning setting that was created by streaming pupils according to Ability did not have any significant effect on the performance of the pupils.

## 4.4 SECONDARY ANALYSIS

An analysis of the observation data and the pupils response on the pupils' Questionnaire are presented in this section. First an analysis of the interaction initiated by each pupil in the Group setting is presented. Then an analysis of the views of the pupils of various Abilities on the Learning settings is given.

### 4.4.1 Observation Data

An analysis of the nature of interaction initiated by each pupil in the groups, helped to explain the performance by error type described earlier, at each Ability level. The nature of free interaction was analyzed separately for content related to algorithms and to computational and algebraic manipulations. This analysis was however not task specific. Table 4.12 summarizes the results of group interaction analysis.

The rows in Table 4.12 show the interaction variables related to algorithms and to computations while the columns represent the number of instances of the interaction variables for each Ability level.

As can be seen in Table 4.12 the high-ability pupils quite often described or explained specific features of the algorithms but rarely received explanations of the algorithms. It was also noted that high-ability pupils in nearly every group directed the group work and stated overall objectives and delegated work to other members of the group.

The following excerpt was an example of a high-ability pupil describing the objectives of the task without providing a clue about how to carry it out.

'We first express  $2/3$  in terms of logarithms using the basic law of logarithms that the logarithm of any number to the base of that number is one. Since all the numbers will then be expressed in terms of logarithms, we can compare the logarithms and work out the solution for  $x$ .'

A high-ability pupil in another group stated more clearly.

'First translate  $2/3$  to logarithm to base eight. Then compare logarithm to base

eight on the left hand side with that on the right hand side and work out the solution for x.’

**Table 4.12. Number of instances of free interaction initiated by each pupil.**

Interaction Variable	Ability		
	High	Medium	Low
Algorithmic			
Stating or describing algorithm	45	34	8
Explaining algorithm in response to need	45	14	5
Receiving explanations of algorithms	9	20	52
Computational or Algebraic Manipulations			
Stating or describing calculations	35	17	7
Explaining calculations in response to need	39	14	2
Receiving explanations of calculations	18	14	33

Delegation of work included ‘write out the logarithm to base eight. Now compare those’. High-ability pupils spent much time calculating and explaining how to carry out calculations but received few explanations about calculations. High-ability pupils often checked and corrected calculations of other members. An example is illustrated below.

‘Eight raised to power  $2/3$  is the same as 2 raised to power 2, which simplifies to four,’ or ‘No, because eight raised to power  $2/3$ , is not the same as eight multiplied by  $2/3$ ’.

Some high-ability pupils even explained steps in a specific calculation.

‘Since three times x is equal to seventeen, we have to divide 17 by three to give us the value of x’.

High-ability pupils spent most time describing or explaining the algorithms than calculating and explaining how to perform the calculations.

The medium-ability pupils on the other hand quite often explained how to carry out algorithms to other members of the group. They rarely explained the algorithms in response to need and also received explanations of the algorithms. The following extract shows a medium-ability pupil carrying out the algorithm after a high-ability pupil had stated the objective of the problem.

High: You translate  $2/3$  to base 8

Medium: To do it we multiply  $2/3$  by logarithm of base eight. We then take eight to power  $2/3$ . To simplify, we first take the cube root of eight, which gives us 2. We then square two to give us four.

The medium-ability pupils participated in doing calculations but rarely explained how to carry them out but received explanations about them. Medium-ability pupils often failed to detect errors made by other members. No medium-ability pupil detected the following error made by another group member. 'Eight raised to power  $2/3$ , is equal to eight times one third everything squared.

Some medium-ability pupils expressed lack of confidence in their ability to perform calculations and asked other members for answers to simple calculations. Some medium-ability pupils did not even attempt calculations.

Low-ability pupils rarely participated in setting up or explaining the algorithms, but they often solicited and received explanations from other members. The following extract is typical of the explanations that the low-ability pupils received.

Low: So what did you do here?

High: I first changed everything to base eight

Low: Why base eight?

High: Since the other logs have been expressed to base eight, the constant also has to be expressed to base eight.

Low: So that is  $2/3$  times log eight to base eight

High: This will then be simplified to eight raised to power  $2/3$

Low: Yes

High: We now take the cube root of eight since it is known to be 2.

Low: Oh, okay, then we square two to get four.

In explanations to the low-ability pupils, other members of the group made certain that the low-ability member understood how to carry out the algorithms. The low-ability pupils performed some calculations but often received explanations about how to perform the calculations especially when they made errors. Low-ability pupils then often received explanations about the algorithms and about computational and algebraic calculations.

In summary, describing the algorithms may have helped pupils to understand and to solidify in memory how to carry out the algorithm. Pupils were able to locate their

own area of difficulty by describing it rather than by listening to others describe it. Being the target of explanations may have helped the pupils to understand the algorithms more than merely reading text materials. The other members of the group may have understood a particular member's difficulty and was able to help the pupil experiencing difficulty to understand the algorithms. The group sessions were also too brief to remedy deficiencies in computation that months of classroom instruction could not remedy.

The findings above explained inconsistent results of studies comparing achievement in different Learning settings. Peterson and Janicki (1979) found that receiving explanations was not related to achievement. Webb's (1980) analysis of group interaction showed that merely participating in a teacher-learner relationship was not sufficient for high achievement. Beane and Lemke (1971) found that high and low-ability pupils participated in group interaction when learning new material. There was therefore an increased performance for all the pupils. This helped to explain the increased performance of the low-ability pupils who were frequent recipients of explanations. The dismal performance of the high-ability pupils and could have resulted from carelessness rather than lack of knowledge. It was also noted that the most frequent interaction was between the high and the low-ability pupils. This also helped to explain why the performance of medium-ability pupils in both settings was nearly the same.

#### **4.4.2 Questionnaire Response**

In response to questionnaire for the high-ability pupils, ten respondents agreed that there were steps they could not understand. Six of the high-ability pupils agreed that they could understand the steps when working individually and the other six agreed that they understood the steps when working in the groups. All high-ability pupils agreed that they were not helped to understand the difficult steps while ten respondents agreed that they helped others solve questions they could not understand.

From this analysis, it can be seen that the high-ability pupils preferred either of the two Learning settings to help them understand some steps they could not understand. The high-ability pupils helped other pupils to solve problems they could not understand but received little help on the concepts they themselves could not understand. The high-ability pupils in the Group setting were thus generally active in helping other pupils understand the steps they could not understand.

Twenty of the medium-ability pupils agreed that there were steps they could not understand while four did not. Six of the medium-ability pupils agreed that they understood the steps when working individually while eighteen of them agreed that they understood the steps when working in the Group setting. Nineteen of the medium-ability pupils agreed that they were shown the steps they could not understand while five disagreed. However, half of the medium-ability pupils agreed that they helped other pupils solve problems they could not understand while the other half said they did help other pupils solve questions they could not understand. This could have helped the pupils to locate their own area of difficulty and therefore learn in the process of explaining.

The medium-ability pupils thus generally preferred the Group setting to the Individual setting. From their responses, the medium-ability pupils were partly active and partly passive in the learning activities of the Group setting. Even though most of the medium-ability pupils were shown how to solve problems, they also helped others who had difficulties to solve some of the questions. Their being passive in the activities of the group could have hindered their learning of the tasks.

For the low-ability pupils ten respondents agreed that there were steps they could not understand. One low-ability pupil agreed that he understood the steps while working individually while eleven agreed that they understood the steps when working in the Group setting. Ten low-ability pupils agreed that they were shown steps they could not understand while two did not agree. Two low-ability pupils however said that they helped others solve problems they could not understand while ten of them did not help others solve the problems. It was therefore generally seen that nearly all the low-ability pupils preferred the Group setting. Nearly all of them agreed that the Group setting helped them understand the steps they could not understand.

On which setting the pupils thought was favourable to them, five high-ability pupils felt they highly benefited from the Individual setting while seven of them felt they did not. Eleven of the high-ability pupils thought they benefited highly from the group discussions while one felt he did not. On the Learning settings the pupils preferred, ten high-ability pupils preferred both the Individual and Group settings while two of them preferred only the Group setting. The high-ability pupils therefore felt both Learning settings were favourable to them.

For the medium-ability pupils, six of them thought they highly benefited from the Individual setting while the rest did not. All the twenty-four medium-ability pupils

thought they greatly benefited from the Group setting. This indicated that the Group setting was very popular among the medium-ability pupils. However only eight preferred the Group setting alone while sixteen of them preferred both the Individual and Group setting. The majority of the medium-ability pupils therefore preferred both settings with the Group setting being the most popular.

For the low-ability pupils, five of them thought they benefited highly from the Individual setting while seven of them did. All the low-ability pupils felt they benefited highly from the Group setting. One of the low-ability pupils preferred the Individual setting, three preferred the Group setting while eight preferred both settings. It was therefore seen that the Group setting was very popular among the low-ability pupils though most of them preferred to have both settings.

On the way, the pupils interacted with their classmates and with pupils from other classes, nine high-ability pupils responded that they often had group discussions in class while three said they never had them. All of them thought their classmates were very useful and that they helped others in the classroom solve difficult problems. One high-ability pupil however said he consulted pupils from other classes in case of difficulties while eleven did not. Six high-ability pupils however formed discussion groups, with other pupils from other classes. Eight of the high-ability pupils also thought that they performed well in class while four of them thought they did not.

For the medium-ability pupils, nineteen of them agreed that they had such discussions in class while five disagreed. Twenty of them thought that their classmates were useful while four thought that they were not useful. They also agreed that they help others in their class to solve difficult problems. The ratio was 23:1. Twenty of them agreed that they consulted pupils from other classes while four did not consult pupils from other classes. Half of the medium-ability pupils responded that they formed discussion groups with other pupils while the other half did not. However fourteen thought they performed well in class while ten agreed that however much they tried, they did not perform well in class.

For the low-ability pupils, half of them agreed that they had such discussions in class while the other half did not. Five of them thought that their classmates were helpful while the other seven thought that they were not. Eight low-ability pupils said they helped others in their class solve difficult problems while four did not. Four of them also agreed that they consulted other pupils in case of difficulties while eight did not. Four of

them agreed that they formed discussion groups with other pupils while eight of them did not. Five of them also felt that they performed well in class while seven said they did not perform well however much they tried. This showed that the classroom setting was not perceived to be beneficial to the learning opportunities of the low-ability pupils. The majority of the low-ability pupils thought that their classmates were not useful in helping them solve difficult problems.

On their opinion of which system of allocating pupils to classes the pupils preferred, nine of the high-ability pupils said they wanted to be in the same class with members of their group. The others did not. The same number of pupils agreed that they liked the system of streaming used to allocate them to classes, and also that the system makes them learn better. Three of them did not however like the system. These opinions showed that the high-ability pupils preferred either streaming or non-streaming. They seemed not to mind either of the methods used to place them in classes.

For the medium-ability pupils, eighteen of them felt they wanted to be in the same class with members of their group while six of them did not. This further gave evidence that the medium-ability pupils also liked a class with pupils of mixed-ability. However three pupils said they liked the system of streaming that was used to allocate them to classes in their schools while twenty-one of them felt they did not. The three medium-ability pupils also thought the system made them learn better while the rest felt it did not. Therefore the majority of the medium ability pupils preferred the system of non-streaming to the one of streaming that was used in their school.

For the low-ability pupils, nine of them liked to be in the same class with other members of their group while three did not. However, eleven of them did not like the system of streaming that was used to place them in classes while one thought he liked the system. Two of them also felt the system helped them learn better. This further gave evidence of the kind of feelings the low-ability pupils had against the system of streaming. Nearly all of them seemed to prefer the system of non-streaming.

From the opinions highlighted above it was clear that both Learning settings were favourable to the high-ability pupils. Majority of the medium-ability pupils preferred the Group setting while nearly all the low-ability pupils preferred the Group setting. This could be attributed to the fact that the Group setting enabled the low-ability pupils to ask for help from other members of the group when they needed such help. The low-ability pupils must have therefore experienced a more stimulating and active Group Learning

setting that helped them understand the concepts better.

It was also seen that the high-ability pupils interacted with their classmates while they minimally interacted with members of other classes. This showed that the high-ability pupils had a passion for seeking more information using whichever means available. They tried to maintain their positions at the top and competed favourably with members of their class. The medium-ability pupils on the other hand consulted pupils from other classes in case of difficulties. This could have been due to the fact that they felt their classmates were not very useful. This opinion agrees with the fact that lack of some knowledgeable pupils in their class made the medium-ability pupils go looking for them out of their class.

The low-ability pupils felt their classmates were not helpful. This could have been due to the fact that the poor and the good pupils should have been mixed so that they shared ideas. The opinion of low-ability pupils thus suggested that their class environment seemed less stimulating for any kind of achievement.

The medium and low-ability pupils therefore preferred the system of non-streaming while the high-ability pupils showed no preference for streaming or non-streaming. These findings were consistent with research done in Kenya. Wawire (1996) in a study on the experiences of students in a streamed school found that high-ability pupils favoured the system of streaming while low-ability pupils complained of unequal allocation of resources and poor attitudes of their teachers. This was a demotivating factor for the low-ability pupils. Kimokoti (1982) found that the majority of schools in Kenya were practicing mixed-ability grouping. The main reason for this could have been to avoid the devastating effect of streaming on the low-ability pupils.

#### **4.5 SUMMARY AND CONCLUSION**

Data analysis of the study revealed the following; the Group setting appeared to reduce the total error scores of all pupils compared to the Individual setting. The Group setting was therefore good for medium and low-ability pupils on Algebra. The high-ability pupils must have influenced the performance of the low-ability pupils in the Group setting since their performance was the same. Logarithms and Indices seemed to be understood better than Algebra. Therefore on Algebra, the Group setting greatly reduced the mean error score of all the pupils over the Individual setting.

Two way ANOVA analysis results:-

- a) Did not reject the null hypothesis of no significant effect of the Learning setting on the total error scores at 0.05 level of significance.
- b) Rejected the null hypothesis of no significant effect of Ability on the total error scores at 0.05 level of significance.
- c) Did not reject the null hypothesis of no significant interaction effect of the Learning setting and Ability on both Task 1 (Algebra) and Task 2 (Logarithms and Indices) at .05 level of significance.

Two-way ANOVA results also showed that the Mathematics tasks only affected significantly the performance of the high-ability pupils, but not for the medium-ability and low-ability pupils at 0.05 level of significance. The interaction effect of the Learning setting and the Mathematics Tasks was significant only for the low-ability pupils at 0.05 level of significance but not for the high-ability and medium-ability pupils.

Secondary analysis indicated that high-ability pupils in the Group setting quite often described or explained algorithms and computations but rarely received explanations of algorithms and computations as expected. The medium-ability pupils quite often explained how to carry out algorithms but rarely explained the algorithms in response to need. The low-ability pupils rarely participated in explaining algorithms but quite often solicited and received explanations from other members.

From the response on the Questionnaire, the high-ability pupils had no preference for either of the two Learning settings. The medium-ability pupils generally preferred the Group setting and nearly all the low-ability pupils agreed that the Group setting helped them understand better all the steps involved in the exercise. The high-ability pupils agreed that they liked the streaming procedures used their school while the medium and low-ability pupils did not it.

From the findings of the preliminary analysis, it was concluded that:

- a) The Learning setting had no significant effect on the performance of the pupils but descriptive analysis showed an effect, which was not significant. Therefore whether the pupils were in a streamed setting or a non-streamed Learning setting did not have any effect on their performance.
- b) Ability of pupils as expected, had a significant effect on the performance of the pupils. The high-ability pupils in either setting performed best while the low-ability pupils performed worst.

- c) There was no significant combined effect of the Learning setting and Ability on the pupils' performance. From descriptive data the performance of the low-ability pupils was however seen to greatly depend on the Group Learning Setting.
- d) The Mathematics Tasks only had a significant effect on the performance of the high-ability pupils but not the medium and low-ability pupils. Task 2 was thus understood better than Task 1.
- e) There was a combined significant effect of the Learning setting and the Mathematics Tasks only for the low-ability pupils. The performance of the low-ability pupils on particular tasks therefore depended on the Learning setting of the pupils.

From the findings of secondary analysis, it was concluded that: -

- a) The high-ability pupils played an important role in assisting other pupils in the Group setting explain the steps of the tasks.
- b) The medium-ability pupils did not actively participate in explaining the steps but also solicited and received explanations from the high-ability pupils.
- c) The low-ability pupils benefited from the explanations given by the high and medium-ability pupils. Most of their interactions were limited to soliciting for explanations.
- d) The high-ability pupils showed no preference for either of the two Learning settings while the medium-ability and low-ability pupils preferred the Group setting.

Soliciting for explanations and getting help improved the performance of the low-ability and medium-ability groups. Giving explanations also helped high-ability pupils to identify their own areas of difficulty and thus understood the tasks better. This led to an improved performance. Secondary analysis results helped to explain the learning activities of the Group that led to the improved performance of all the pupils over the Individual setting. The Group setting was therefore seen as important in determining pupil achievement.

The summary, conclusions and recommendations are presented in the next chapter.

## **CHAPTER FIVE**

### **SUMMARY CONCLUSION AND RECOMMENDATIONS**

#### **5.0 INTRODUCTION**

This chapter presents a summary of the study, conclusions drawn from the study and recommendations based on the findings. This is presented in four sections. Section one looks at the summary of the findings. Then the conclusions that were drawn from the study are discussed. The third section discusses the recommendations that were made from the findings while the last section gives some recommendations for further research.

#### **5.1 SUMMARY OF THE STUDY**

The study was mainly concerned with the effect of the Learning setting created by streaming, on the achievement of pupils. The study investigated whether the Learning setting created by streaming played a significant role in determining pupil achievement. The study was also concerned with whether the effect of the Learning setting would depend upon the Ability level of the pupils. The sample consisted of Form Three secondary school pupils from an urban government secondary school. The school streamed its pupils according to Ability. The study involved analysis of data from 48 pupils randomly selected from a pool of 240 Form Three pupils. A stratified random sampling technique was used with Ability as stratifying criteria. A factorial research design was used in the study. The factors studied were; the Learning setting and the Ability levels. The Learning setting had two levels namely the Individual learning setting and the Group learning setting. Ability had three levels namely high-ability, medium-ability and low-ability levels. The dependent measures

used were the total error scores on two Mathematics tests namely Algebra and Logarithms and Indices. The instruments used for data collection were Mathematics achievement tests, an Observation checklist and a Pupils' Questionnaire. Learning materials were also developed for use in the study.

Descriptive analysis was used to describe the performance of the pupils by error type and also the mean error score of the pupils on both Task 1 (Algebra) and Task 2 (Logarithms and Indices). The findings showed that the total errors made by the pupils in the Group setting (62.1%) were fewer than those made by pupils in the Individual setting (72.9%) on Algebra test. However on Logarithms and Indices the total error scores in the Individual setting was (51.25%) slightly less than in the Group setting (54.6%).

The mean error scores of the pupils in the Individual setting (7.31) were higher than the mean error score in the Group setting (5.77) on Task 1. On Task 2, the mean error score of the pupils in the Individual setting (4.89) was not very different from the mean error score in the Group setting (5.22). The difference in performance on the two tasks was due to the fact that Logarithms and Indices seemed to have been understood more properly than Algebra.

Two-way Analysis of Variance was used for hypotheses testing. The major findings of this study were as follows: -

- (a). There was no significant relationship between the Learning setting and the total error scores on both Task 1 and Task 2. This meant that whether the pupils were in the Individual or the Group Learning setting, it did not have a significant effect on the total error scores on mathematics tests. Descriptive data however indicated that there was an effect of the Learning setting, though not significant.
- (b). There was a significant relationship between Ability and Total Error Scores on both Task 1 and Task 2. This meant that the pupils of high-ability made very few errors on achievement tests than those of medium and low-ability. Post-hoc analysis using Tukey test statistic showed that the mean error score of the high-ability pupils was significantly lower than the mean error score for medium-ability pupils on Task 1. On Task 2, the mean error score of the high-ability pupils was significantly lower than that of the medium and low-ability pupils..
- (c). There was no significant combined effect of the Learning setting and Ability on the total error scores on both Task 1 and Task 2. This meant that whichever Learning setting pupils were exposed to, it did not have any significant effect on

their total error scores.

- (d) There was a significant relationship between the Mathematics Tasks and the total error scores only for the high-ability pupils but not for the medium-ability and low-ability pupils. This indicated that pupils performed much better on Task 2. This was because Task 2 was better understood than Task 1.
- (e) There was a significant combined relationship between the Mathematics Tasks and the Learning setting only for the low-ability pupils, but not for the high and medium-ability pupils. This indicated that the performance of the low-ability pupils on particular Tasks depended significantly on the Learning settings the pupils were exposed to. The Group setting greatly influenced the performance of the low-ability pupils. The Group setting was thus better than the Individual setting on Algebra while on Logarithms and Indices the performance of low-ability pupils was almost the same.

The findings of descriptive data indicated that the Learning setting had some effect on the total error scores, though this was not significant. The Group setting seemed to be better than the Individual Setting on Task 1. The performance in both settings on Task 2 was almost the same. The basic concern in streaming is that it created a Learning setting that promoted individual learning. This study has indicated that a mixed-ability group learning setting greatly influenced the performance of the medium-ability and the low-ability pupils. This showed that with a well structured Group setting, the low-ability pupils can score better on achievement tests which is only achieved if the class has pupils of mixed-ability.

Ability was seen to have an effect on the total error scores. Pupils of high-ability made significantly fewer errors than those of medium-ability and low-ability. Descriptive data however showed the performance of the pupils of different abilities also depended on the Learning settings they were exposed to, on both Tasks. This was however not significant. The high-ability pupils greatly benefited from the Individual setting on Task 2 while the low-ability pupils greatly benefited from the Group setting on Task 1.

This finding indicated that a streamed Learning setting was only catering for the bright pupils but not for the weak pupils. On Algebra task it was seen that the performance of the high-ability and low-ability pupils was the same. This indicated that the high-ability pupils might have greatly influenced the performance of the low-ability pupils. This influence was consistent with Vygotsky's Social Cultural Theory, which

emphasized an interaction between skilled and unskilled partners jointly solving problems together, was very essential in moulding a child's cognitive functions. The interaction of the skilled high-ability and unskilled low-ability pupils helped to mould the cognitive functions of the low-ability pupils. This was indicated by the reduction in the mean error scores of the low-ability pupils in the Group setting over the Individual setting.

The study also complied with the Social Cognitive Theory by Bandura which stated that the presence of other pupils made the pupils in the Group setting to engage in interaction and thereby learn the tasks by observing others executing them. The low-ability pupils therefore learned a great deal by observing the high-ability pupils execute the tasks. The findings thus indicated that the presence of the high-ability pupils in a non-streamed setting would greatly influence the performance of the low-ability pupils.

Descriptive data also showed that the performance of the pupils depended on the tasks. This was shown to be significant only for the high-ability pupils. Pupils therefore performed better on the task that was better understood. The combined effect of the Learning setting and the Mathematics Tasks was significant only for the low-ability pupils. This indicated that the performance of the low-ability pupils on different Tasks depended on the Learning settings they were exposed to. One Learning setting therefore helped the low-ability pupils understand tasks better than the other Learning setting.

The secondary analysis of group interaction clearly underlined the following points:-

- a) The high-ability pupils in nearly every group directed the group-work and stated overall objectives and delegated work to other members of the group.
- b) The medium-ability pupils typically described the algorithms but often seemed unsure of their calculations.
- c) The low-ability pupils rarely participated in setting up or explaining the algorithm but quite often solicited and received explanations from other members.

It was therefore noted that the experience of the pupils in the group was related to their test performance. Pupils who gave many descriptions of the algorithm, or explained how to perform computational or algebraic manipulations did better than pupils who displayed less of the above behaviour. The low-ability pupils received the most explanations of algorithms while the high-ability pupils gave the most explanations

of computation and algebraic manipulations. Being the target of explanations about the algorithms may have helped all pupils to understand the algorithms more than merely reading text materials. Pupils in the group may have understood a particular member's difficulty and explained the troubling material for the pupils to understand. The high-ability pupils thus engaged in peer tuition. It was also noted that the group sessions were too brief and could not remedy deficiencies in computation.

The findings of group interaction analysis indicate clearly that the Group Learning setting played a significant role in determining pupil achievement. The learning activities of the Group setting helped to explain the reduction in the mean error scores over the Individual setting. It was therefore noted that the presence of pupils of various Abilities in a Learning unit led to the kinds of interaction that were observed to be taking place. This further supported the theories that were earlier stated and therefore helped to explain the increased performance of the Group over the Individual setting.

The findings from the responses on the pupils' Questionnaire were as follows:-

- (a). The high-ability pupils showed no preference for either the Individual setting or the Group setting.
- (b). The medium-ability pupils preferred the Group setting over the Individual setting.
- (c). Nearly all the low-ability pupils preferred the Group setting over the Individual setting.
- (d). High-ability pupils seemed to like the system of streaming that was used to place them in classes.
- (e). The majority of the medium-ability pupils and nearly all the low-ability pupils did not like the system of streaming that was on use.

From the opinions highlighted above it was clear that both Learning settings were popular among high-ability pupils. The Group Learning setting alone was popular among the medium-ability and low-ability pupils. The presence of the high-ability pupils could have helped the other members of the group learn the material. The high-ability pupils did not mind the streaming practice used because they themselves were good at reading and understanding individual instructional materials. On the other hand the low-ability pupils in a streamed setting did not benefit from reading individual instructional materials and their classmates were not helpful in making them understand. They therefore preferred a system of placement whereby there could be some pupils who could

be of great help in making them understand certain concepts. Their opinions suggested the presence of high-ability pupils among them which was against the system of streaming that was in use in their school.

The views of the high-ability pupils indicated that they did not mind any setting they were placed in. The Group setting was popular among the medium-ability and low-ability pupils because they received answers to the questions from the high-ability pupils. This was a remedy to the individual work where they could not ask anybody for help. The high-ability pupils were also co-operative in providing help to enable other pupils understand the tasks. Streaming on the other hand encouraged the pupils to engage in competition and would not help their peers fearing they would perform better than them.

The medium-ability and low-ability pupils' views indicated that a streamed setting made them develop an attitude that they could not perform better however hard they worked. This was in agreement with Bandura's theory of self-actualisation and outcome expectation. The mixed-ability setting thus made them realise that if they asked for help and received it, they would perform better. Their views suggested that the Learning setting greatly influenced pupil achievement. They therefore showed great preference for their classes to have pupils of mixed-ability

## 5.2 CONCLUSIONS

The conclusions that were drawn from the findings of this study were as follows:-

- (a) The Learning setting had an effect on the performance of the pupils on both Task 1 and Task 2, though this was not significant.
- (b) Ability alone had a significant effect on the performance of the pupils on both Task 1 and Task 2.
- (c) There was an interaction effect of the Learning setting and Ability on the total error scores of the pupils on both Task 1 and Task 2, though this was not significant.
- (d) There was a significant effect of the Mathematics Tasks on the total error scores only for the high-ability pupils but not for the medium-ability and low-ability pupils.
- (e) There was a significant combined effect of the Learning setting and the Mathematics Tasks only for the low-ability pupils but not for the high and

medium-ability pupils.

Descriptive analysis showed some effect of the Learning setting though this was not significant. From this analysis it was concluded that the Group Learning setting was beneficial to pupils of all Abilities, with the low-ability pupils being the greatest beneficiary. The mixed-ability Group setting therefore helped the low-ability pupils learn better than the Individual learning setting.

The high-ability pupils were quite essential in directing the group work, stating overall objectives and delegating work to other members of the group. The presence of the high-ability pupils in the group made the low-ability pupils to solicit and receive explanations of the material they did not understand. The mixed-ability group session therefore played an important role on the learning outcome of the pupils though this was not significant.

The medium-ability and low-ability pupils showed great preference for the Group Learning setting over the Individual Learning setting. From their opinions it was concluded that they wanted such group sessions to be within their own classroom. This was only possible if the pupils within their class were of mixed-ability.

It was therefore concluded that the method of streaming used to place the pupils in their classrooms, thus promoting individual learning, was not popular among the medium-ability and low-ability pupils. They instead showed preference for classrooms with pupils of mixed-ability, therefore creating a mixed-ability Learning setting. It was however concluded that streaming had an effect on the learning outcome of the pupils though this was not significant.

### **5.3 RECOMMENDATIONS**

From the findings of the study the following recommendations were made.

- (a) Mixed-ability group discussions should be encouraged in most secondary schools, Group discussions were conducive to better learning in all the three ability groups.
- (b) Education policy makers in Kenya should encourage head teachers to set up mixed-ability classes against those with pupils of similar ability. This is because education should be geared towards catering for the needs of the pupils of all abilities.

- (c) Teachers should develop a lot of interest in the learning activities of the low-ability pupils and help them instead of concentrating on the high-ability pupils .

#### **5.4 RECOMMENDATIONS FOR FURTHER RESEARCH**

For the purpose of investigating further effects of streaming on academic achievement, it was recommended that the following be carried out:-

The findings of the study indicated that the Learning setting had an effect on the performance of the pupils though this was not significant. This could have been due to the fact that the study was only limited to a small sample of 48 pupils randomly selected from a pool of 240 pupils. This sample was small, and was quite convenient for the experimenter to use in the study. None of the subjects in the sample dropped out of the study. The experimental study was only possible with a small sample since it was done in a particular setting and at the same time. This was to control for possible intervening variables that may have threatened the validity of the findings. It was therefore recommended that the study be replicated with a larger sample of pupils.

The current study was limited to only one boys' secondary school that streamed its pupils according to Ability. The findings of the study cannot therefore be generalized to other secondary schools like Girls' schools and mixed secondary schools that also streamed their pupils according to Ability. The study was also limited to only the Form Three class. The findings cannot therefore be generalized to other Forms in the school. On the basis of these limitations, it was recommended that the study be replicated in the secondary schools cited above and also in the different Forms. A similar study can also be carried out at other levels of education like the primary schools, colleges or in the university.

The present study was only limited to two new tasks in Mathematics namely Algebra and Logarithms and Indices. It would be interesting to find out whether the findings would apply to other subjects also.

The present study was done using a quasi-experimental design. The pupils might have reacted to the artificial nature of the study. It was therefore not possible to assess whether the Learning setting alone actually had an effect on the total error scores. Further the study did not assess the entry behaviour of the pupils to determine

whether the Learning setting alone did have a significant effect. It was therefore recommended that the present study be replicated using the true experimental design and use of a control group. In this design the pupils would first be given a pre-test to determine the entry behaviour before they are exposed to the Learning settings. In this design it was recommended that a control group be used to control for any effects that may arise due to the artificial nature of the study.

The duration of the present study was limited to three weeks. This was not quite a sufficient duration for the pupils to learn properly the Mathematics tasks. The short duration of the study was also necessary to control for the teacher effect. These Tasks were new to the pupils and they were going to learn them in class. It was therefore recommended that the study be replicated using more Tasks and requiring a longer duration of time.

The current study has provided alternative methods of classroom organization that can supplement the classroom teaching. The study has shown how an Individual Learning setting can be structured for increased performance of the pupils. The pupils were shown how to use individual instructional materials in their learning activities. The pupils might have had the instructional materials but they did not know how to use them for their own studies. This was quite necessary for high achievement.

The study has also shown how a mixed-ability group can be structured to cater for the needs of pupils of all Abilities. The pupils were shown how to interact by helping members of the group experiencing difficulties. Peer-to-peer tutoring was quite necessary given the inability of teachers to attend to individual needs of the pupils. The high-ability pupils located their own areas of difficulty by providing explanations to others. This was a good way of locating difficulties rather than reading individual materials. Therefore a well structured mixed-ability group plays an important role in the achievement of all the pupils.

The current study has shown that streaming makes pupils of various Abilities develop personal convictions. The high-ability pupils feel they are the best while the low-ability pupils always felt they were backward and that was why they were discriminated against by other pupils. This had a discouraging effect on their performance. On the other hand a mixed-ability setting encourages a lot of co-operation among the pupils. The high-ability pupils recognize the difficulties of their peers and therefore help them. The low-ability pupils also realize they can get help

from the high-ability pupils and therefore solicit for the help. The study has shown that peer tuition is an important supplement to classroom teaching.

The current study has investigated the effects of streaming using a quasi-experimental design. This has contributed to the little research that has been done in this area in Kenya. Most studies on streaming used methods that do not manipulate independent variables and that had little control of intervening variables. This study has shown that the independent variables can be manipulated and that there can be a lot of control of intervening variables. The findings of the study are of great significance to not only the teachers and their classroom practice but also to headteachers, education policy makers and parents.

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## MATHEMATICS

### INSTRUCTIONS: Answer all questions.

Q1. (2 marks)

Q2. A fruit seller brought  $x$  apples for a total cost of shs 300. Write down an expression for the average cost of each apple. He found that two were bad and sold the rest at shs 6 for each apple and found that he paid for it. Write down an expression for the selling price of each apple. If he made a profit of shs 120 form an equation for  $x$ , solve it and find how many apples he brought for sale. (5 marks)

for  $x$  is the equation without solving for within a tick.

$$0 - 2 + \log_{10}(2x + 10) = \log_{10}(3-4) \quad (5 \text{ marks})$$

Q2. Given that algorithm to base ten of two is 0.3170 and if  $\log_{10} 2 = 0.3010$  find  $\log_{10} 4$  and  $\log_{10} 8$  using mathematical relations. (5 marks)

# APPENDICES

## APPENDIX A

### MATHEMATICS ACHIEVEMENT TESTS

**INSTRUCTIONS: Answer all questions in these tests.**

#### Test 1

- Q1. If the quadratic equation  $x^2 + 2(a-2)x + a = 0$  has equal roots, what are the possible values of  $a$ ? (5 marks)
- Q2. A fruit seller bought  $x$  apples for a total cost of shs 300. Write down the expression for the average cost of each apple. He found that two were bad and sold the rest receiving for each apple sh3 more than he paid for it. Write down an expression for the selling price of each apple. If he made a profit of shs 132, form an equation for  $x$ , solve it and find how many apples were bought initially. (5 marks)

#### Test 2

- Q1. Solve for  $x$  in the equation without using logarithm tables  
 $(\log_{10} 5) - 2 + \log_{10} (2x + 10) = \log_{10}(x-4)$  (5 marks)
- Q2. Give that logarithm to base ten of two is 0.3110 and that logarithm to base ten of three is 0.4771, find without using mathematical tables the value of logarithm to base ten of the cube root of sixty. (5 marks)

# MARKING SCHEME

## Test 1

- Q1.  $x^2 + 2(a-2)x + a = x^2 + 2kx + k^2$  A--- 1
- Comparing
- $2(a-2) = 2k$
- $a = k^2$  A--- 1
- $a = (a-2)^2$
- $a = a^2 - 4a + 4$
- $a^2 - 5a + 4 = 0$  C--- 1
- $a^2 - 4a - a + 4 = 0$
- $a(a-4) - (a-4) = 0$  C--- 1
- $(a-1)(a-4) = 0$
- $a = 4$  or  $a = 1$  C--- 1
- 
- Q2 Cost for one apple =  $\frac{300}{x}$
- Remaining apples =  $(x-2)$  A----1
- Selling price =  $\frac{(300 + 3)}{x}$
- 
- Equation  $\frac{(300 + 3)}{x} (x-2) = 132 + 300$  A---1
- 
- $(300 + 3x)(x-2) = 432x$
- $3x^2 - 138x - 600 = 0$
- $x^2 - 46x - 200 = 0$  C---1
- $(x-50)(x+4) = 0$  C---1
- $x = 50$  or  $x = -4 = 0$
- Ignore -ve
- $X = 50$  C----1

Test 2

- Q 1.  $\text{Log } 5 - \text{log } 100 + \text{log } (2x + 10) = \text{log } (x - 4)$  A---1  
 $\text{Log } \frac{5}{100} (2x + 10) = \text{log } (x - 4)$  A---1  
 comparing  
 $\frac{5}{100} (2x + 10) = (x - 4)$  A---1  
 $(2x + 10) = 20(x - 4)$  C---1  
 $18x = 90$   
 $x = 5$  C---1

- Q 2.  $\text{Log } \sqrt[3]{60}$   
 $\frac{1}{3} \text{log } 60$  A---1  
 $\frac{1}{3} (\text{log } 10 \times 6)$   
 $\frac{1}{3} [\text{log } 10 + \text{log } 2 + \text{log } 3]$  A---1  
 $\frac{1}{3} [1 + 0.4771 + 0.3010]$  C---1  
 $= \frac{1.7781}{3}$  C---1  
 $= 0.5927$   
 $= 0.593 \text{ to } 3 \text{ dp}$  C---1

Key

- A Algorithmic error  
 C Computational or algebraic error

# APPENDIX B

## OBSERVATION CHECKLIST

Group ..... Task .....

### 1. Variables related to Algorithms

#### (a) Stating or describing an algorithm

H	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>1</sub>	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>2</sub>	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

#### (b) Explaining algorithms in response to need

H	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>1</sub>	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>2</sub>	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

#### (c) Receiving explanations of algorithms

H	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>1</sub>	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>2</sub>	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

2. Variables related to computational or algebraic manipulations.

(d) Stating or describing calculations.

H	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>1</sub>	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>2</sub>	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

(e) Explaining calculations in response to need.

H	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>1</sub>	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>2</sub>	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

(f) Receiving explanations of calculations

H	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>1</sub>	0	0	0	0	0	0	0	0	0	0	0	0
M <sub>2</sub>	0	0	0	0	0	0	0	0	0	0	0	0
L	0	0	0	0	0	0	0	0	0	0	0	0

Responding to a specific pupils need was defined as responding to pupils question, statement of confusion or error.

**APPENDIX C**  
**PUPILS' QUESTIONNAIRE**

Class..... Group.....

**Instructions**

Answer the questions below as honestly as possible by ticking whichever applies to you.

1. Were there steps you could not understand?  
  
(a) Yes..... (b) No .....
  
2. Did you understand the steps when working individually?  
  
(a) Yes..... (b) No .....
  
3. Did you understand the steps when working in the group?  
  
(a) Yes..... (b) No .....
  
4. Were you shown the steps you could not understand?  
  
(a) Yes..... (b) No.....
  
5. Did you help others solve problems they could not understand?--+  
  
(a) Yes..... (b) No.....
  
6. Did you highly benefit from the individual work?

- (a) Yes ..... (b) No .....
7. Did you highly benefit from the group discussions?
- (a) Yes ..... (b) .....
8. Which setting would you prefer?
- (a) Individual ..... (b) Group ..... (c) any.....
9. Do you often have such discussions in class?
- (a) Yes ..... (b) No.....
10. Are your classmates helpful?
- (a) Yes ..... (b) No. ....
11. Do you help others in your class solve difficult problems?
- (a) Yes ..... (b) No. ....
12. Do you consult students from other classes in case of difficulties?
- (a) Yes..... (b) No.....
13. Do you form discussion groups with them?
- (a) Yes ..... (b) No. ....

14. However much you try, do you perform well in class?

(a) Yes ..... (b) No.....

15. Would you like to be in the same class with members of your group?

(a) Yes ..... (b) No.....

16. Do you like the system used to allocate pupils to classes in your school?

(a) Yes ..... (b) No.....

17. Do you think the system makes you learn better?

(a) Yes ..... (b) No.....

## APPENDIX D

### LEARNING MATERIALS

**INSTRUCTIONS:** Work through the following questions.

#### ALGEBRA

- Q1 If  $4x^2 - 10x + K$  is a perfect square, find the value of  $K$  and hence the roots of equation  $4x^2 - 10x + K = 0$ .
- Q2. What must be added to  $y^2 - 13y$  to make it a perfect square?
- Q3. A dealer bought two-band radios for £450 at a cost of  $\pounds x$  each. He also bought three band transistors for £1320 at a cost of  $\pounds(4x+10)$  each. If he bought 30 of these altogether, form an equation in  $x$ . Solve the equation and hence find the cost of each kind of article.
- Q.4 Given that  $P^2 + 10P + 30$  is equal to  $(P + a)^2 + b$ , Determine the value of  $a$  and  $b$ .
- Q5. The director of a youth centre hires a bus for a trip for which the hiring charge is Kshs.1080. The bus can take  $x$  youths.
- (a) Write down the cost per youth in terms of  $x$  if the bus is completely filled.
- (b) Write down the cost per youth in terms of  $x$  if nine of the seats are not occupied.
- (c) In the latter case, the cost per youth was found to be shs.6.00 more than the former case. Form an equation for  $x$  and hence find the total number of youths the bus can carry.

## LOGARITHMS AND INDICIES

Q1. If logarithm to base ten of 2 is 0.3010 and logarithm to base ten of 3 is 0.4771, find without using tables correct to five decimal places, the values of

- (a)  $\log 18$     (b)  $\log 1.5$     (c)  $\text{Log } 8$     (d)  $\log 4.5$   
(e)  $\log 72$

Q2. Solve for x in the equation

$$\text{Log}_8 (x+5) - \log_8 (x-3) = 2/3$$

Q3. Given that logarithm to base ten of 3 is 0.4771 and logarithm to base ten of 5 is 0.6990. Evaluate without using log tables logarithm to base ten of 18 correct to 3 significant figures.

# **APPENDIX E**

## **PILOT STUDY**

### **PURPOSE**

- (i) To estimate the time taken for the learning session and the time for test administration.
- (ii) To determine the item quality.
- (iii) To obtain the reliability estimate for the Mathematics achievement tests.
- (iv) To check the adequacy of the observation scale and the Learning materials.
- (v) To pre-test the response of the items on the pupils' Questionnaire.

### **SAMPLE**

The sample for this study consisted of twelve Form Three pupils from a parallel secondary school with the ones used for this study. Three of the pupils were randomly selected from the Form 3A stream, six from the Form 3C stream and the last three from the Form 3E stream.

### **DESCRIPTION OF THE STUDY**

The pupils were assigned to three groups each consisting of a pupil from the Form 3A stream, two from the Form 3C stream and one pupil from the Form 3E stream. The pupils were given the Learning materials and were shown how to use them for individual learning and also for learning by group interaction. In the group sessions trained research assistants noted the interaction initiated by each pupil. After the last learning session, the pupils took two tests administered under examination conditions.

### **RESULTS AND RECOMMENDATION**

Three weeks of instruction was found to be sufficient for the learning process on the two tasks on Algebra and on Logarithms and Indices. The tests were administered under power conditions. The pupils had no difficulty with the instructions given on the tests.

The alpha-coefficient method of estimating reliability was used because the test items were not scored dichotomously. The alpha formula used for estimating reliability was as shown below.

$$\text{Coefficient alpha } (\alpha) = \frac{k(1 - \sum \sigma^2_i)}{k-1 \sigma^2_t}$$

Where k = No. of items

$\sigma^2_i$  = The variance of each item

$\sigma^2_t$  = The variance on the entire test

The reliability estimate for the Mathematics achievement tests was found to be 0.75. It was therefore assumed that the tests were internally consistent and stable.

The tests were therefore found to be suitable for use in the main study. The research assistants had no difficulty scoring the Observation checklist. It was however found more suitable to make pupils sit round a table in the order of their Abilities. This was to make the observers have an easy way of identifying the pupils in the three Ability levels. The H, M and L notations were found to be confusing to the observers. These were changed to the classes the pupils came from.

The pupils had no difficulty responding to the items on the pupils' Questionnaire. They had no difficulty with the instructions. The average time for administration of the Questionnaire was about thirty minutes. The pupils' Questionnaire was therefore found to be adequate for use in the main study.

There was no difficulty with instructions on the Learning materials that were prepared for use in the main study. The Learning materials were found to be very suitable for use in the main study.

## **APPENDIX F**

### **SCHOOLS IN THE STUDY**

Kisumu Boys High School

Kisumu Girls High School

**KENYATTA UNIVERSITY LIBRARY**