PREVALENCE AND NATURE OF MATHEMATICAL DIFFICULTIES AMONG GRADE 5 PUPILS IN SELECTED SCHOOLS IN LUSAKA PROVINCE

BY

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A DISSERTATION SUBMITTED TO THE UNIVERSITY OF ZAMBIA IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF EDUCATION DEGREE (SPECIAL EDUCATION).

THE UNIVERSITY OF ZAMBIA

LUSAKA

MARCH, 2006

DECLARATION

I **Kalima Kalima,** do declare that this dissertation is my own work which has not been submitted for a degree to this or any other University.

Signature: ....

Date: 6/6/2006

DEDICATION

I dedicate this work to my departed mother Julia C. Kalima and sister Mwangala Kalima. To my wife Linda Banji Siamuzyulu Kalima, my father and siblings for all the love and support I have received throughout my academic life.

APPROVAL

This dissertation by Kalima Kalima is approved as partial fulfilment of the requirements for the award of the Master of Education Degree (Special Education) of the University of Zambia

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ACKNOWLEDGEMENTS

I would like to express my indebtedness to all the members of the Department of Educational Psychology, Sociology and Special Education for the support and patience they offered during my study for this programme. In particular, I would like to express my gratitude to my supervisor Dr. O.C Chakulimba for his guidance throughout the production of this dissertation.

I would like to thank Dr. Manchishi for his professional and fatherly advice; Mrs T. Milapo-Sichilongo who, while in the Staff Development Office, made the researchers academic life easier when it would otherwise have been impossible to go through. Mr Mwape for the tireless effort to make sure we had all the necessary requirements to carryout this research, I am indebted to him. I thank Ms Beatrice Matafwali for taking time out of her busy schedule to read my dissertation.

I thank the officers at the Ministry of Education for allowing me to carry out my research in the five (5) schools of Lusaka Province. I thank the school managers and teachers at Lusaka Girls' and Boys', Vera Chiluba, Mwembeshi and Shantumbu Basic Schools for their cooperation during the data collection period. I am also grateful to the grade five pupils in the schools in which the data were collected.

My lovely wife, Linda Banji Siamuzyulu-Kalima, (the genius) for your support, love, care and push at every stage of this work, I am grateful to you, only God will reward you for your goodness.

I will be eternally grateful to God for the life and being He has given me. Nothing would have happened without the hand of the most High God.

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ABSTRACT

This study investigated the prevalence and nature of mathematical difficulties among grade five pupils in selected schools of Lusaka Province. The objectives of this study were:

- To establish the proportion of fifth graders that experience difficulties in mathematics in selected schools in Lusaka urban and rural.
- To establish whether there is a difference in prevalence of mathematical difficulties between male and female pupils.
- To establish the nature of mathematical difficulties experienced by grade five pupils in Lusaka Province.
- To determine the extent to which specific psychological skills correlate with mathematical competence.

The pupils were selected using the random sampling method. The sample consisted of hundred and twelve (112) participants, 57 females and 55 males from both urban and rural schools.

In order to assess their mathematical skills, two instruments were used, the Mathematics of Zambia Achievement Test (ZAT-M) which was an instrument developed by the University of Zambia and the YALE University; the Grade Five National Assessment (G5NA), a test developed by the Examinations Council of Zambia to assess learning achievement of children in grade five. The Universal Non-verbal Intelligence Test (UNIT) was used to measure the cognitive skills of the children to see how the UNIT scores correlated with mathematical achievement.

The results of the study indicated that 4.5 % of the children had scores falling 1.5 standard deviations below the mean. This means that 4.5% of the sample population had mathematical difficulties. The results further showed that there was a difference in prevalence of mathematical difficulties between the male and female participants (males 4.5% in the ZAT-M and 3.6% in the G5NA; the females 7.3% in the ZAT-M and 4.5% in the G5NA). The results also showed that there was a difference in performance between the rural and the urban participants on all of the tests in the study.

The results also showed that children had different types of mathematical difficulties. Some had difficulties in number computations, fact retrieval difficulties, mathematical word problems, principles of calculation, estimations and others had problems with identification of numbers and number place values.

The results further showed that there was a significant correlation between the mathematical tests and the intelligence test.

From the findings of this study, it may be relevant for the Examinations Council of Zambia to review the manner in which examinations are taken to include those children who may have adequate mathematical skills but have poor reading skills.

Teachers should be made aware of the specific problems children may experience in order to maximum the benefit of the children from the instruction process.

CHAPTER ONE

INTRODUCTION

Background to the Problem

Learning Difficulties according to Wong (1995) constitute the largest percent of cases in the field of Special Education. There are several studies that have been conducted to ascertain the extent to which learning difficulties exist in schools and in the general population. Further, attempts have been made to investigate the prevalence and types of these Learning Difficulties. However, according to Mercer and Mercer (1993), problems in mathematics have not received as much attention as the other types of learning difficulties such as reading, writing and attention.

Studies in the field of mathematics have shown that approximately 6% of school-age children have significant mathematical difficulties (Kosc, 1974 and Badian, 1983). Among students classified as learning disabled, mathematical difficulties are seen to be as persistent as reading problems, estimated at 5 to 8% of school age children (Strauss, 2003). Alder (2001) estimates that of the general school population, 5 to 6% of children have mathematical disabilities. The Learning Disability Website estimates that between 6 and 7 % of the school age children face difficulties in mathematical processes. Research seems to indicate that mathematical problems emerge early in life, but continue throughout academic and social life. This would imply that problems in mathematics are common at all age-levels.

Other studies (Garnett, 1998; Geary, 1999 and Spreen et. al., 1995) further observe that the nature of these difficulties varies from one child to another. Some of these include inability to master basic arithmetic facts; poor computation skills, inability to connect abstract concepts to real life, poor understanding of mathematical language and poor visual-spatial aspects of mathematics.

While it is established that a considerable number of pupils experience difficulties in mathematics, little is known about the exact prevalence and nature of mathematical difficulties in Zambia.

Statement of the Problem

Although several studies have shown that Mathematical Difficulties (MDs) are numerous and varied, there is very little or no research that has been done to ascertain the nature of the problem and the extent to which these problems exist in schools in Zambia. The aim of this study was, therefore, to investigate the *prevalence* and *nature* of mathematical difficulties among Grade 5 pupils in selected schools in Lusaka Province.

Purpose of the Study

The purpose of this study was to investigate the prevalence and the nature of mathematical difficulties among 5th grade pupils in selected schools in Lusaka Province.

Objectives

The following were the objectives that guided the study:

General Objective

The general objective of this study was to determine the prevalence and the nature of mathematical difficulties among Grade Five pupils in selected schools of Lusaka.

Specific Objectives

- To establish the proportion of fifth graders that experience difficulties in mathematics in selected schools in Lusaka urban and rural.
- To establish whether there is a difference in prevalence of mathematical difficulties between male and female pupils.
- To establish the nature of mathematical difficulties experienced by grade five pupils in Lusaka Province.
- To determine the extent to which specific psychological skills correlate with mathematical competence.

Research Questions

The study was guided by the following questions:

- What proportion of grade 5 pupils has mathematical difficulties?
- Is there a difference in prevalence of mathematical difficulties between male and female pupils?
- Is there a difference in performance between the rural and urban samples on the different mathematical and intelligence tests?
- What types of difficulties do children face in carrying out mathematical computations?
- To what extent do intellectual skills correlate with performance in mathematical tests?

Significance of the Study

The ability to process mathematical concepts is not only important in the classroom but also in the day-to-day activities of life. One has to be able to compute correctly in order to make correct judgments in life (Lerner, 1997). The effects of failure in mathematics throughout the years of schooling, coupled with innumeracy in adult life, can seriously handicap both daily living and vocational prospects in one's life. In today's world, mathematical knowledge, reasoning, and skills are no less important than reading ability (Paulos, 1989).

It is clear that poor performance in mathematics, like in any other subject, can often stand in the way of a child's academic success. It has been noted that early recognition of the problems a child is experiencing can help the child overcome the difficulties. Children who face challenges in understanding and using mathematics will most often avoid subjects that have an orientation in mathematics and, in turn, reduce their chances of making a career in the sciences. This will in turn affect the number of people who will be involved in the countries' technological advancement.

Grouws and Cebulla (2000) posit that the best way to help a child learn any subject is to understand how the child finds solutions to problems presented. Often when the teacher does not have this information, the instructional strategies may not be meaningful for the individual child.

It is hoped that the results of this study will help teachers and educational administrators understand the extent to which children experience mathematical difficulties. Further it is hoped that the findings will bring more insights on the mathematical learning styles of children, how they generate solutions to problems and what problems they face in their problem solving strategies.

Theoretical Framework

This study was guided by the *cognitive approach* to learning which is a child-centred learning theory. It focuses on how people receive, process and recall information (Bredo, 1997). Specifically, the study used the *specific-abilities model*, which brings a bridge between assessment of a child's learning difficulties and remedial programmes. This model considers the child's learning problems as caused by some underlying deficits in psychological processes.

These processes are seen to be separate and distinct which, when combined, reflect the ability needed to acquire academic skills. Unless there is sufficient understanding of the nature of mathematical difficulties faced by children, instructions will be meaningless. Copeland (1979), and Underhill et al. (1980) assume that failure of the teacher to understand how the child thinks and finds solutions to problems, contributes to the child's failure to benefit from the learning process. Instruction is not sensitive to the learning needs of the child.

Operational Definitions

Cognitive Characteristics: These are the psychological characteristics that may be exhibited in specific group of children, examples of these could be the memory skills, visuospatial skills, and problem solving skills.

Computation Skills: This refers to the ability to carryout arithmetic processes.

Learning Disabilities: these are difficulties in one or more of the basic psychological processes involved in understanding or use of language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations.

Mathematical Difficulties: this is a type of learning disability in which a person has normal language development but has significantly below average mathematical skills.

Visual-spatial Skills: This refers to the ability to visually perceive spatial relationships among objects

Visual Perceptual: This is the ability to see and interpret visual stimuli. For example the ability to discriminate, synthesize and analyze between colours, foreground-background, form or shape, size, and position in space.

Organisation of the Remaining Chapters

The dissertation presents the findings of the study on the nature and prevalence of MDs in Grade Five pupils in selected schools in Lusaka Province. Chapter two discusses literature elated to the prevalence and nature of MDs. Chapter three discusses the methodology, study sample, instruments used in data collection, data collection procedures and limitations of the study. In chapter four, the findings and analyses of the study are presented. The discussion of the study findings is contained in chapter five. Chapter six contains the conclusion and recommendations for further research.

CHAPTER TWO

LITERATURE REVIEW

It is not until recently that mathematical difficulties have received attention in research. Shalev (2004) observes that while mathematics has a prime importance in our daily life, the aspects of normal and abnormal development of mathematical skills has received very little attention compared to reading and writing skills. While it is true that mathematics has not received much attention, studies that have been conducted, have yielded a wealth of insights into the nature and prevalence of mathematical difficulties (Geary and Hoard, 2001).

This chapter reviews literature on the development of mathematical skills, prevalence, gender differences and characteristics of children with MDs. The Chapter further highlights the other factors that may contribute to poor performance in mathematical competence such as poor memory and visual-spatial skills.

Development of Mathematical Skills

Before discussing Mathematical Difficulties, it would be worthwhile to highlight the Development of normal mathematical skills. Mathematics is a complex subject, which involves among other things, language, space and quantity. It involves reasoning, developing problem-solving skills and remembering facts about different concepts and theories (Landerl et al., 2003). Unless a child is able to use these skills together and independently, it may be difficult to generate solutions to problems. According to Barakat (1951) and Wrigley (1958), mathematical skills involve several factors and various different skills. They hypothesise that mathematical competence involves the ability to perceive space, remember facts, language processing and adequate problem-solving skills. Children employ these skills when they are dealing with other types of mathematical problems.

In his article "The Development of Arithmetic Abilities", Butterworth (2005) notes that children need to acquire skills in reading and writing numbers, counting objects, use of the four basic mathematical operations (division, multiplication, addition and subtraction), and then apply these skills in counting money, telling time and dates, and so forth.

Shalev (2005) argues that unlike the skills for reading which have to be taught, children, and of course adults, have a biological propensity to learn mathematics without necessarily going through formal schooling. Before children go to school, they are able to add, subtract, compare and understand quantities. Dehaene (1997) observes that children are able to count up to four items and these skills become more complex and sophisticated with advance in age. Children are able to make more complex and abstract mathematical computations. They normally move from the basic skills of counting all, to a more complex counting-on strategy. The former involves counting each object in order to find a solution to a problem, while the latter employs a strategy of building from the last added and continue to add until the child finds the answer. In a problem '4+3', a child using the count all strategy will begin at one and count until he or she reaches 7. A child who uses the count-on strategy will start at 4 and count, five, six, seven to arrive at the answer 7 (Dockrell and Mcshane1992).

Ardila et al. (1993) suggest that mathematical abilities represent multifactor skills, which include verbal, spatial, memory and problem solving skills. Children begin with simple counting strategies and develop mastery at the basic facts and eventually become competent users of mathematical skills. Failure to develop mastery is likely to impede learning of higher-order mathematical skills.

Prevalence of Mathematical Difficulties

Mathematical Difficulties are not a uniform disorder. Children with MDs can manifest an array of different numerical errors. There are variations in terms of the types and severity of the MD (Grafman, 1988). According to Prior (1996), estimating the prevalence of MDs is difficult because of the lack of a universal definition of the problem.

Lewis, Hitch and Walker (1994) studied 1056 unselected 9 to 10-year-old English children (the entire age group within a particular socially heterogeneous, local education authority; excluding only those assessed as having severe general learning difficulties). They were given the Ravens Matrices IQ Test, Young's Group Mathematics Test and Young's Spelling and Reading Test. About 1.3% of the sample had specific mathematical difficulties, defined as a mathematics scaled score of 85 or below despite a Ravens IQ score of 90 or above. A further 2.3% had difficulties in both reading and mathematics (scaled scores of 85 or below in both the reading and mathematics tests) despite a Ravens IQ score of 90 or above. Thus, the prevalence of mathematical difficulties in children of normal IQ was 3.6%. The children with mathematical difficulties were equally divided between male and female participants.

Gross-Tsur, Manor and Shalev (1996), assessed the incidence of mathematical difficulties in a cohort of 3029 Israeli 11- to- 12-year-olds. The 600 children who scored in the lowest 20% on a standardized city-wide mathematics test were selected for further testing. Five hundred and fifty five were located and given an individualized arithmetic test battery previously constructed and standardized by the authors. This included reading, writing and comparing numbers, comparing quantities, simple calculations and more complex (multi-digit) calculations. One hundred and eighty-eight children or 6.2% of the total number were classified as having mathematical difficulties, using the criterion of a score equal or below the mean for children two years younger. One hundred and forty-three of these children were located and received parental consent for further testing. This included the WISC-R IQ test, and reading and spelling tests standardized on seventy age-matched typically developing children. Three children were excluded from the 'dyscalculic' group because they obtained below eighty in IQtests. Of the one hundred and forty dyscalculic children, seventy-five were girls and sixty-five were boys, once again indicating an approximately equal gender distribution. Their IQs ranged from eighty to one hundred twenty-nine, with a mean of 98.2. The study by Gross-Tsur et al seems to suggest that the prevalence of MDs are relatively common and that the prevalence is similar between genders.

Bzufka, Hein and Neumarker (2000) studied 181 urban and 182 rural German third-grade pupils. They were given standardized school achievement tests of arithmetic and spelling. Twelve children in each sample (about 6.6% of the whole population) performed above the 50th percentile in spelling, but below the 25th percentile in mathematics. When the urban and rural children were compared, they showed little difference in incidence of specific spelling or mathematics difficulties, but the urban children [who were on the whole from a lower socio-economic background] were far more likely than the rural children to have difficulty with spelling and mathematics, (48.6% versus 3.3% respectively).

Desoete, Roeyers and DeClercq (2004) carried out a study in Belgium, where they gave a standardized mathematics test to nearly 4000 second-to-fourth grade children. They combined evidence from the test (performance at least two standard deviations from the mean on at least one section) with teacher ratings. Incidence of dyscalculia ranged from 2.27% in second grade to 7.7% in third grade (6.59% in fourth grade). It is unlikely that the incidence would have in fact differed so much at the different ages; and the differences probably reflected differential sensitivity of the test at different ages, perhaps combined with reluctance on the part of teachers to label children as mathematically disabled at a young age.

Gender Difference in MD Prevalence

Gender distribution of mathematical difficulties has been a subject of much controversy. Some studies have assumed that it is more frequent in boys than girls whereas others consider that MDs tend to affect both sexes equally (Ardila and Rosselli, 2002). According to Zhang and Wilson (1998), differences in performance of males and females can be masked by looking at total score alone without paying attention to the specific areas in which the males and females differ.

It should be noted that the prevalence of mathematical difficulties tends to vary because researchers use different definitions and also measure different skills in their investigations. Casey et al (2001) studied one hundred and eighty-seven Grade 8 pupils. They compared spatial-mechanical skills and mathematics self-confidence as mediators of gender differences in mathematics. Using items showing the largest male and female advantage on the Third International Mathematics and Science Study (TIMSS) U.S. data, they created mathematics Male and Female subtests from items on the 8th-grade TIMSS. Using path-analytic techniques, they decomposed a significant gender/mathematics correlation, favouring males, on the TIMSS-Male subtest into direct and indirect effects. They found only indirect effects. A spatial-mechanical composite accounted for 74% of the total indirect effects, whereas mathematics self-confidence accounted for 26%. By 8th grade, girls' relatively poorer spatial-mechanical skills contribute to lower scores on types of mathematics at which boys typically excel.

Royer et al (1999) carried out nine studies to investigate the extent to which automatic fact retrieval skills predict performance in mathematics. They concluded that automatic fact retrieval predicted mathematical performance in grade 5 to grade 8. Males from select populations received better scores on standardized mathematics achievement tests than females. The study by Royer et al (1999) indicates that the mathematics-fact retrieval hypothesis is consistent with previous research. This hypothesis may help in the explanation of the origin of gender differences in mathematics and reading and relates those differences to the existing literature on gender differences in academic performance.

Nature of Mathematical Difficulties

Children who face mathematical difficulties are characterised by an inability to grasp and remember mathematical concepts, rules, formulas, sequence (order of operations), and basic addition, subtraction, multiplication and division facts. Further, they are seen to have a poor long term-memory (retention & retrieval) of concept mastery (Garnett, 1992).

As mathematics learning continues, school-age children with language processing disabilities may have difficulty solving basic mathematical problems using addition, subtraction, multiplication and division. They struggle to remember and retain basic mathematical facts (i.e. multiplication tables), and have trouble figuring out how to apply their knowledge and skills to solve mathematical problems. Difficulties may also arise because of weakness in visual-spatial skills, where a person may understand the needed mathematical facts, but have difficulty putting them down on paper in an organized way. Visual-spatial difficulties can also make understanding what is written on a board or in a textbook challenging (Ardila, 1993).

Dowker (2004) argues that in order to study the nature of mathematical difficulties experienced by children, it is important to remember that mathematics is not a single entity. There are several components including knowledge of mathematical facts, ability to carryout mathematical procedures, understanding and using mathematical principles; estimation and applying mathematics skills in finding solutions to word- and practical problems.

Cohn (1961) hypothesises that there are five basic abilities necessary for mathematical competences, namely: the recognition of numbers and operands, number ordering, static memory for multiplication tables, dynamic memory for carrying over results and additions. He conducted case studies of clients who had difficulties with calculations, and concluded that there were three underlying causes of mathematical difficulties. The first being poor skills in number ordering, the second cause he identified was a poor memory and lastly he observed that his "patients" did not realise when to stop using a specific operation and use another.

According to Bryant (2005), when a child is identified as having a mathematical difficulty, the difficulty may stem from problems in one or more of the following areas: memory, cognitive development, and visual-spatial ability. She observes that *Memory* problems may affect a child's ability to retrieve (remember) basic arithmetic facts quickly, recall the steps needed to solve more difficult word problems, and steps in solving algebraic equations. Poor *cognitive development* may hinder learning and processing information and understanding number systems. She further observes that *visual-spatial* difficulties may result in misaligning numerals in columns for calculation and problems with place value that involves understanding the base ten systems. Some children have been seen to have sufficient grasp of mathematical facts but have weak computational skills. They are inconsistent in their calculations and make many computational errors.

Russell and Ginsburg (1984) compared fourth graders specifically identified as having MD, to typical third and fourth graders on a variety of skills. Although the performance of the three groups on some conceptual and computational skills was comparable, students with MD scored worse on counting large numbers, identifying multiples of large numbers, and using basic fact within calculations.

Basic facts play an important role in mathematics. In order for students to work efficiently, flexibly, and accurately with numbers, they need both conceptual understanding of number relationships and quick access to basic facts. Research by LaBerge and Samuels (1974), Lesgold (1983) and Torgesen (1984) support the notion that fluency in basic skills is a necessary prerequisite to higher-level functioning in both reading and mathematics. They suggest that children often do poorly in these subjects because they may have failed to master the subcomponent processes required to understand text and to solve mathematical problems.

In the beginning children may be required to learn facts about the multiplication tables, dividends of common numbers and some basic additions. This skill will need to be mastered in order for a child to learn higher order mathematical skills. Simple mathematical problems, such as '3+6' or '5x4', are frequently encountered and routinely solved in every-day life. Problems whose solutions do not require further computational processes or strategies but can directly be retrieved from long-term memory are commonly referred to as mathematical facts (Dohams and Delazer, 2005).

Teachers frequently note that "not knowing basic math facts" is a common and conspicuous difficulty, an impediment to higher-level math, and a corrosive influence on the self-confidence of students with learning disabilities. Research confirms that many of these students are seriously inefficient in calculating basic number facts (Pellegrino & Goldman, 1987).

Geary et al. (1999) observe that children with MDs have difficulties remembering basic arithmetic facts, such as the answers to 5+3 or 3x4. It is not that children with MDs do not remember any arithmetic facts, but rather they do not remember as many facts as other children do and appear to forget facts rather quickly.

Shalev et al. (1988) conducted a study to investigate the computational errors in children with mathematical difficulties. They studied the errors of eleven children with MDs and ten matched control children. Their findings seem to suggest that there were no significant differences observed in comprehension and number production scores. However, significant differences seemed to emerge in their performance on fact retrieval, addition, subtraction, multiplication and division scores. The children with MDs had more difficulties in fact retrieval even though they could calculate using other strategies.

Jordan and Hanich (2003) conducted a study of 74 children who had moderate mathematical difficulties and normal reading (MMD-only), Moderate Reading and Mathematical Difficulties (MMD/MRD), another group that had moderate reading difficulties but normal mathematics skills (MRD-only), another group had normal reading and mathematical skills. They found that children with or without reading difficulties, were characterized with weaknesses in fact retrieval and also estimation skills.

It is widely held that solving mathematics word problems is different from solving number-fact problems. Most word problems require analysis and interpretation of the given information before deciding on solutions (Parmar, Cawley, and Frazita, 1996). One fairly common difficulty experienced by children with mathematical difficulties is the inability to easily connect the abstract or conceptual aspects of mathematics with reality.

The study by Tabakamulamu (1998) which consisted of 116 children from grades 5-7 from Lusaka and Mongu Urban primary schools revealed that most of the children, approximately 50% had difficulties understanding concepts in mathematics. There was no significant difference in location; performance was relatively the same in both provinces.

Memory as Predictor of Mathematical Achievement.

Although the relationship between working memory and difficulties in executing arithmetic procedures is not fully understood, it is clear that children with MDs have working memory problems (Geary, 2004). The ability to remember numbers and mathematical principles requires that a child has good working memory capacities. Geary (1993) suggests that poor working memory resources not only lead to difficulty in executing calculation procedures, but also affect learning of mathematical facts. It has been pointed out early in this chapter that one needs to master mathematical facts if high-order mathematics will be learnt. Unless the memory skills of a child are intact, the ability to recall mathematical facts will be impaired.

Koontz and Berch (1996) tested children with and without MDs using both digit span and letter span tasks. The study found that children with MDs performed below average on both digit span tasks and letter span tasks, indicating a general working memory difficulty.

Passolunghi and Siegel (2004) conducted a study to investigate the relationship between working memory, mathematical ability, and cognitive impairments of 49 children with difficulties in mathematics. They found that children with MDs were significantly deficit in working memory.

Mclean and Hitch (1999) conducted a study on children who had mathematical difficulties. They found that children with MDs had poor skills for spatial working memory and executive functions.

Visual- spatial Aspects of Mathematics

While visual ordering involves appreciating and producing information in a particular sequential order, spatial ordering involves appreciating and producing information in an appropriate form. Each plays an important role in mathematical abilities. Gearheart (1986) observes that poor perceptual skills may lead to difficulties in discriminating between operations, numbers, and decimal places. He further observes that it may also affect the ability to read multi-digit numbers correctly and identifying pattern in sequence problems.

Garnett (1992) adds that children with mathematical difficulties exhibit deficits in visuospatial skills. The most severe mathematical difficulties have been linked to visuospatial deficits.

Kulp et al. (2004) conducted a study to investigate whether or not poor mathematics achievement was related to performance on test of visual discrimination and memory. An investigation of visual perception and mathematical achievement in 171 children from grade two to six (mean age = 10.08 years) from a middle class primary school were investigated. Visual perception skills were assessed using the Visual Motor Integration Test of Visual Perception and a new test of visual memory. They controlled for age and verbal ability in all the regression analyses. Using logistic regression analysis, the study showed that poor visual perception skills were significantly related to poor mathematics abilities. They concluded that poor visual perceptual ability is one of the skills significantly related to poor mathematics achievement.

As already stated above, the prevalence and nature of MDs in other countries has been studied, little or no studies have been done in Zambia. It can be concluded, however from the preceding literature that the problem of MDs is real and prevalent in the school population. This information can be used as a starting point for Zambia to conduct investigations into the prevalence and nature of MDs in Zambia.

CHAPTER THREE

METHODOLOGY

This chapter discusses the methodology of the study, the study design, the sample and sampling procedures, the instrumentation for data collection and methods of data processing.

Research Design

The study employed both the quantitative and qualitative methods of data collection. The children were given individual assessments using the instruments highlighted below. Each child was given three tests, one was a group-administered test and the other two were individual tests. The children took turns in taking the individual tests.

The variables under investigation in this study were:

Dependent variables: score on mathematical tests of the Zambia Achievement Test, National Assessment. The subtests in these tests were, Accuracy on Number Combination, Mathematical Fact Retrieval, Computation Estimation, Mathematical Story Problems, Understanding of Principles of Calculation, Understanding and Representation of Place Value, Number Identification and Position Knowledge. The other dependent variable that was investigated was the participants' scores in the Universal Non-verbal Intelligence Test (UNIT).

Independent Variables: Urban or Rural area in which the school is situated and the sex of the participants.

Population

The population of the study was restricted to grade five pupils from government schools in Lusaka Province. The grade five pupils were selected because they had been in school long enough to grasp the basic numeracy skills and therefore, problems experienced in learning may easily be identified at this stage. Rosselli and Ardila (2002) observe that while addition skills of children are observed during the first and second grades, pupils are only able to manipulate these principles in the third and fourth grades.

Sample and sampling procedure

The sample was drawn from five (5) government schools in Lusaka Province. The schools from which the sample was drawn were ranked into two categories, three schools were in the urban area and the other two schools were in the rural area. This was in order to provide an equal representation in relation to the socio-economic status of the participants.

Thirty (30) grade five pupils were selected from each of the two schools in Lusaka Rural and another sixty-five pupils were selected from three schools in Lusaka Urban using the systematic sampling method bringing the total number of participants to one hundred and twenty-five. In the sample from the urban area, seventeen pupils were selected from a single sex school for girls and another eighteen were selected from a school exclusively for boys. The sample was made of a total number of one hundred and twelve pupils (112), 50 pupils from Lusaka Rural and 62 pupils from Lusaka Urban. Some pupils fell out of the sample because they did not take all the tests that were administered in this study.

Table 1: Gender distribution in the Study Sample.

The table below presents the distribution of gender in the study sample.

Sex	**Area**		**Total**
	Urban	Rural	
Female	31	26	57
Male	31	24	55
Total	**62**	**50**	**112**

The study sample consisted of a total of 112 participants. An attempt was made to have an equal number of sexes in the sample. The rural sample had two females more than males. This was because some males did not take all the tests and therefore were left out of the analysis.

Table 2, below presents the age distribution of the sample in the study

Table 2. Age distribution of Sample

Area	Mean	N	Std. Deviation	Minimum	Maximum
Urban	11.24	62	1.29	9	14
Rural	12.38	50	1.55	10	17
Total	**11.75**	**112**	**1.52**	**9**	**17**

The sample consisted of children whose ages ranged from nine years to seventeen years. The mean age of the sample was 11.75 years. The rural area seemed to have pupils who were as old as seventeen years.

Description of the Schools

Vera Chiluba: This school is situated in a high-density area of Lusaka city. Most of the pupils who attend school here are from the high-density areas surrounding the school.

Lusaka Boys' School: This school is situated in a low-density area of Lusaka. The pupils who attend school in this school come from high, low and medium density residential areas.

Lusaka Girls' School: This school is adjacent to Lusaka Boys' school. It has most of its pupils from the low density areas of Lusaka.

Mwembeshi School: This school is situated approximately forty (40) kilometres away from Lusaka City. It is a government school, which is a few meters from the main road.

Shantumbu School: This school is situated in the 30 (thirty) kilometres southeastern side of Lusaka city. All of the pupils attending this school are from the surrounding villages.

Data Collection Instruments

One of the instruments used in the study was the achievement test instrument known as the *Zambia Achievement Test-Mathematics* (ZAT-M). The *Mathematics* subtest consists of 61 items that closely mirror the progression of the content of the mathematics curriculum in Zambia. Items are presented in a four-choice response format in which the student must simply point to the correct answer. The researchers read out the questions when administering the ZAT-M and allowed the child to select the most appropriate response initial items instruct students to match a stimulus number with one of four numbers presented. Further items assess ability to compute, estimate, recall number facts, find solutions to word problems, and general problem – solving skills. This instrument was used in a large-scale study for the prevalence of Learning Difficulties in Zambia by the University of Zambia and the Yale University.

The other instrument that was used in the study was the Grade 5 National Assessment (G5NA), which consists of 45 multiple-choice questions. This is an achievement test that was developed by the Examination Council of Zambia to assess learning achievement of Grade Five pupils in schools. The G5NA can determine if a child is delayed in relation to his or her peers in an academic subject area, while a test of specific skills (ZAT) can determine if that delay in academic growth is the result of weaknesses in cognitive ability. The G5NA measures the child's skills in word problems, number identification, numeracy and understanding the principles of calculation. The G5NA is a timed test. Evidence suggests that children's accuracy in calculation may or may not be affected by the constraints of time. In the G5NA, the children were in a testing situation. Each participant had his own test paper on which they were required to read the question and indicate which of the four options provided the correct response.

The results of the two tests were compared to see whether this assumption could be backed by empirical evidence. By looking not only at achievement (as measured by the G5NA), but also at specific skills and processes (as measured by the ZAT), it is possible to gain a better understanding of a child's specific weaknesses. This would help target intervention programmes to strengthen those specific areas of weakness.

In addition to the ZAT-M and the G5NA, we used the *Universal Nonverbal Intelligence Test (UNIT)*. The UNIT is an individually administered ability test that is used to measure general intelligence and cognitive abilities of children and adolescents between the ages of 5 and 17 years. This test assessed the participants' problem-solving skills, visual-spatial skills and spatial memory, which are important constructs for mathematical skill. The total score for each of the subtests was arrived at by adding the total number of correct responses given by the participants.

Data Collection Procedure

The child's demographic information such as the age and sex were obtained. The children were then given the Grade 5 National Assessment Test, which was administered in a group. All the participants in each school were required to take this test at the same time before they took any of the other tests.

The ZAT and the UNIT were administered to each participant individually the following day after they had taken the G5NA.

The areas of mathematical skills assessed are presented in table 3 below.

Table 3. Areas of Mathematical Competence Assessed in the Study

Area	Description
Basic Calculation	Accuracy on number combination Mathematical Fact retrieval Computation Estimation
Problem-solving	Mathematical Word-Problems Understanding of Principles of Calculation
Base-ten Concepts	Understanding and representation of place value, number identification and position knowledge

Adopted from Jordan et al (2003)

Explanation of Mathematical Competence Areas Assessed

Accuracy on Number combination: This set of questions was designed to assess the child's competence in mathematical computations. Children who have mathematical difficulties may be weak in mathematical computations.

Mathematical Fact Retrieval and Computational Estimation: These questions were assessing the child's ability to recall number facts and apply them in a given problem. Children with mathematical difficulties are seen to have a poor mastery of number facts.

Mathematical Word-Problems: The child was given a real life mathematical problem and was required to find a solution. Children with mathematical difficulties have problems transferring mathematical knowledge into reality.

Understanding Principles of Calculation: This skill is important for understanding when to use the different mathematical signs, when to apply specific mathematical concepts and appropriate use of mathematical language. Children who may be experiencing mathematical difficulties may have an incomplete understanding of the language of mathematics and therefore may not be able to use the correct principles in arriving at an answer.

Understanding and Representation of Place Value, Number Identification and Position Knowledge: In order to understand the value of numbers, one needs to identify them and also know the value of the number based on its location in a digit. For instance, the number 7 in 107 and 273 has different values. If a child is unable to differentiate the place value of 7 in the two digits, they may not be able to give an accurate response to a given problem. In this subtest, children were assessed in the ability to understand visuospatial relationships and the perceptual aspects of mathematics.

The Appendix I in this study includes some sample questions that were used to assess the different skills of the participants.

Data Analysis

Descriptive statistics, means, standard deviations, and frequency distributions of test scores on the ZAT-Mathematics and the Grade 5National Assessment (G5NA) were calculated for the whole sample, males and females, and area. Data analyses focused mainly on the differences in mean for gender and area. Correlations for the cognitive tests and the ZAT-M and the G5NA were also investigated. In order to estimate the prevalence of mathematical difficulties among the participants, a cut-off point of 1.5 standard deviations was used.

Limitations of the Study

Due to time and financial limitations, the researchers could only study a small number of pupils in a few schools. Therefore, generalisation of the findings should be made with caution. Another limitation to the study was the fact that some children were present some days and missed some days. This resulted in some of them not taking all the test and, therefore, were left out of the analysis of results.

Ethical Considerations

Before any assessment was carried out in any school, permission was sought first from the Ministry of Education. After this permission was granted further permission was requested from the school managers. Each of the tests was administered only when the school managers had given permission to work in the particular school.

The pupils were assured of the highest confidentiality of the results obtained from the study. It will be observed that even in the reporting of the study findings, no names are mentioned in order to avoid stigmatisation of children who may be experiencing mathematical difficulties.

CHAPTER FOUR

FINDINGS

This chapter presents the findings of the study on the prevalence and nature of mathematical difficulties. The findings are presented under the headings of the prevalence of mathematical difficulties in the sample, the performance of the children on various mathematical skills and the correlations between the intelligence test and the scores in the mathematical tests.

Prevalence of Mathematical Difficulties.

The study set out to investigate, among other things, the extent to which Mathematical Difficulties exist among Grade five pupils in selected schools. In order to find this estimate, a cut-off point was established. Children who had scores falling one and a half standard (1.5) deviations below the mean were taken as facing Mathematical Difficulties (MDs). As with all the other analyses in this study, estimates of the prevalence of MDs are presented for the whole study sample, area and gender.

Prevalence of Mathematical Difficulties in the sample

Using the 1.5 standard deviation below the mean (below 14.61 on the ZAT-M and below 7.04 on the G5NA), the prevalence of mathematical difficulties in the sample population was as high as 4.5% on the ZAT-M and 3.6% on the G5NA. These percentages would represent the number of children experiencing mathematical difficulties among the grade five pupils in Lusaka Province.

Prevalence by Urban and Rural Participants

Further analyses were conducted to investigate whether there were differences in the prevalence between the rural sample and the urban sample. In order to make accurate estimations of prevalence, different means and standard deviations were used. The prevalence of Mathematical Difficulties is presented in table 4 below.

Table 4. Prevalence of MDs in the Rural and Urban Sample.

Area	Test	Mean	SD	<1.5SD
Urban	ZAT-M	54.76	16.2	4.5
	G5NA	40.39	14.59	6.3
Rural	ZAT-M	49.94	14.33	4.5
	G5NA	32	12.17	6.3

The results show that the prevalence of mathematical difficulties in the urban and rural schools was the same. There is a difference in the tests with the ZAT-M (4.5 %) showing a lower prevalence of MDs than the G5NA (6.3%). These are pupils that had scores falling 1.5 standard deviations below the urban and rural means.

Prevalence by Gender

Using the specific means and standard deviations of the male and female participants and a cut-off point of scores falling 1.5 standard deviation below the mean, the prevalence of mathematical difficulties was calculated as shown in table 5 below.

Table 5. Prevalence of MDs by Gender

Gender	Test	M	SD	<1.5 SD
Male	ZAT-M	51.89	18.2	4.50%
	G5NA	35.27	13.96	3.60%
Female	ZAT	53.3	12.51	7.30%
	G5NA	38.23	14.2	4.50%

The results seem to have changed from the ones for the rural verses urban prevalence. In the table above, the data in table 5 shows that there are more females with scores falling below 1.5 SDs in both the ZAT-M and the G5NA, than the male participants.

Performance of Sample on all Tests

The mean performance and standard deviations of the sample on the various tests are presented in Table 6 below.

Table 6: Descriptive Statistics for all the Tests

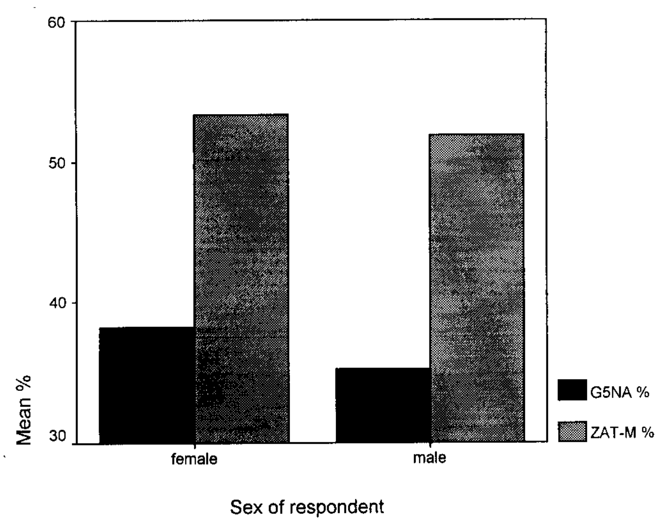
Item	*Min*	*Max*	*M*	*SD*
ZAT-M%	0	85	52.61	15.51
G5NA%	0	71	36.78	14.10
UNIT%	14	53	31.84	10.04
Accuracy in Number Computations(ZAT-M)	0	12	6.06	2.66
Automatic Fact Retrieval (ZAT-M)	0	10	6.70	2.20
Computation Estimation (ZAT-M)	0	7	3.25	1.59
Mathematical Story Problems (ZAT-M)	0	4	1.95	1.09
Understanding Principles of Calculation (ZAT-M)	0	7	3.37	1.71
Place Value and Number Identification (ZAT-M)	0	10	7.73	1.84

The results show that the performance of the sample was generally better in the ZAT-M tests (*M*=52.61%, SD=15.51) than it was in the G5NA (*M*= 36.78, SD=14.10).

Gender differences on the ZAT-Mathematics and the Grade 5 National Assessment

The total scores of the participants on the ZAT-M and the G5NA were converted into percentages. This was in order to compare the percentage scores of the participants on the ZAT-M and the G5NA and how the children's performance differs depending on which test is used. The findings are presented in figure 1 below.

Figure 1 Performance by Gender on the ZAT-M and G5NA



The graph summarises the performance of the male and female participants. The pattern on the graph above shows a similar performance of the females on both the ZAT-M and the G5NA. The mean score for the females on the ZAT-M was 53.30, while that for the males on the same test was 51.89 (SD=18.20).

As regards the performance on the G5NA, the mean score for the females was 38.22 (SD=14.20) and the males had a mean raw score of 35.27 (SD=13.96).

The results were subjected to the analysis of variance test to investigate whether the differences in means were significant. The results show that despite the apparent differences in mean by the genders, the mean difference did not reach statistical significance for gender on both the ZAT-M (F (1,110) = .23, p>.630) and the G5NA (F (1,110) =1.18, p>.279).

However, differences in mean for the schools reached statistical significance. The results of the analysis of variance of the differences in mean between schools on the ZAT-M and the G5NA show that the mean differences were significant on the ZAT-M (F (4, 107) = 3.01, p<0.05) and G5NA (F (4,107) = 5.859, p< 0.01). It could be deduced from the results that there is a difference in performance between the schools on both the ZAT-M and the G5NA.

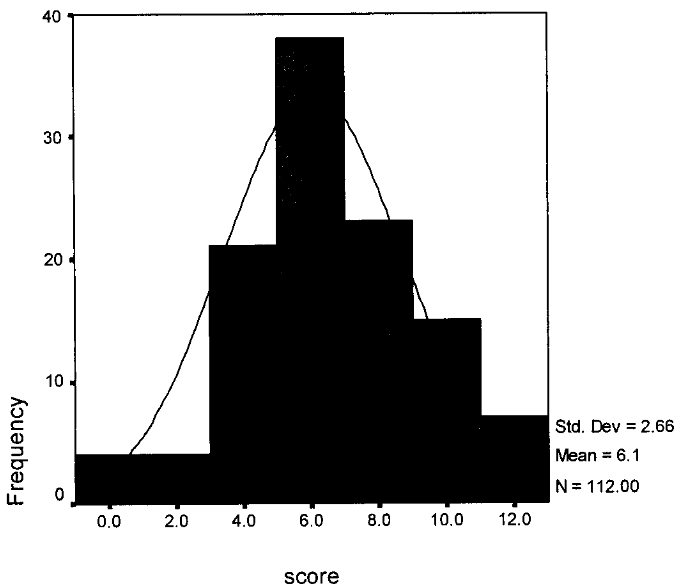
In another test for the analysis of variance between the rural and the urban participants, it was clear that there was a significant difference between the performances of the children in the urban schools and the rural schools. Specifically, the analysis of variance results show that there was a significant different in the G5NA (F (1,110) =9.83, p<0.05). The perceived mean difference on the ZAT-M did not reach statistical significance (F (1,110) = 2.711, p>0.05).

Nature of Mathematical Difficulties

Accuracy on Number Calculations

The participants of the study were given several items that were measuring their ability to carryout basic arithmetic calculations. They were presented with several options for each item from which they had to select the correct response. The results of the children's performance on the accuracy on number facts are presented in figure 2 below.

Figure 2. Accuracy on Number Computation

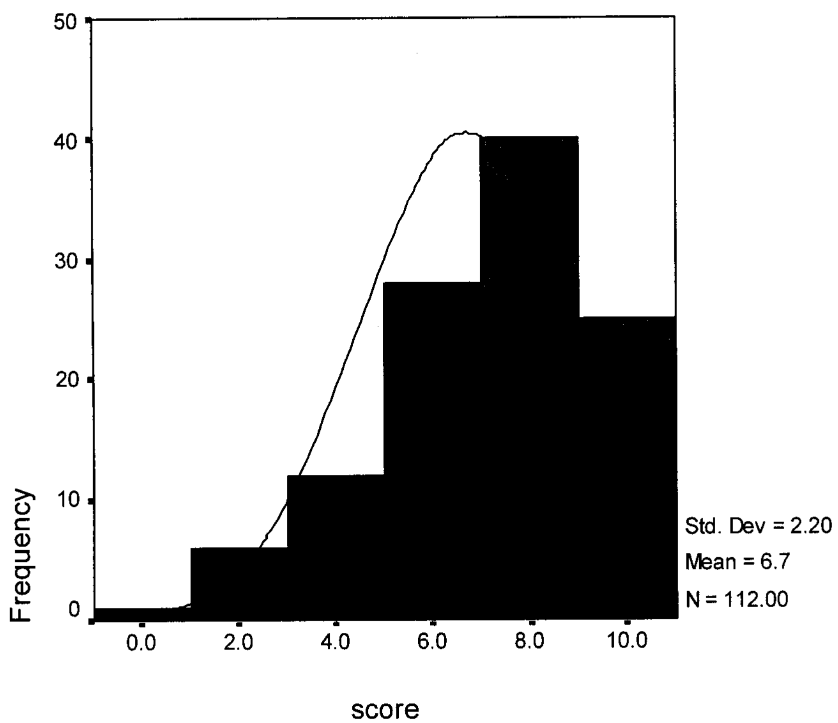


The graph suggests that there was a substantial number of children with inadequate number computational skills. As much as 42% of the pupils had scores falling below 50% of the total.

Mathematical Fact Retrieval

In this subtest, the children were required to recall facts about arithmetic that would help them solve a given problem. The problems required the child to complete a sequence of numbers, differentiate between a large number and a small one based on a known fact. This skills is considered to be important for mathematics (LaBerge and Samuels, 1974, Lesgold 1983, and Torgesen,1984). Adequate skills in fact retrieval will help the child learn more complex mathematical tasks. Figure 3 shows the performance on Mathematical Fact Retrieval.

Figure 3. Mathematical Fact Retrieval

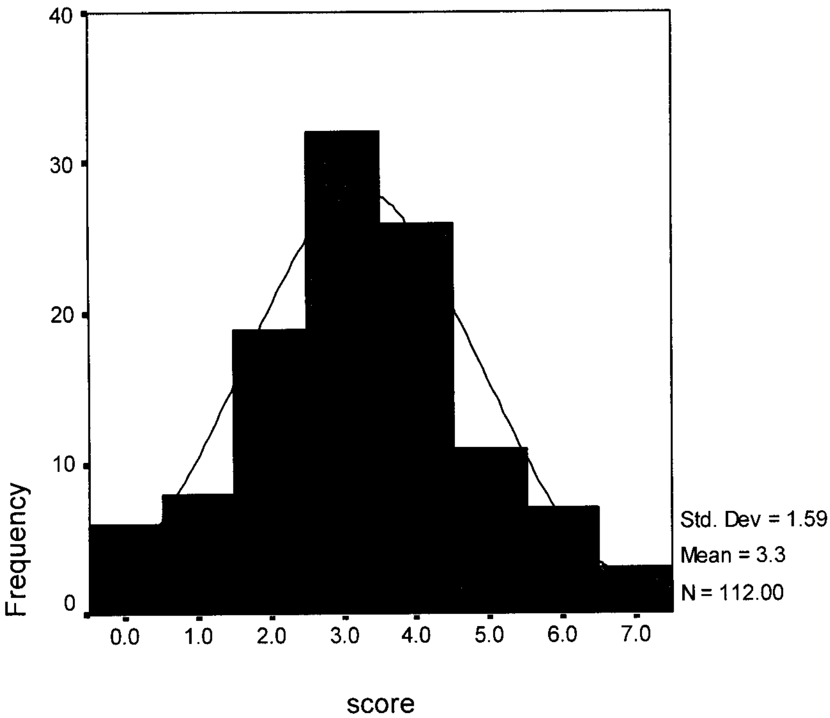


The performance on this subtest shows that most of the children were able to recall facts. As can be seen from the graph above, most of the scores fall above fifty percent. Most of the children were able to remember and apply mathematical facts.

Computational Estimations.

This subtest required the children to estimate the solution to a given problem. The children were required to give an estimate of the product of two large numbers. For example, the child was given a problem to find the product between 687 and 13. There were a total of nine questions that measured this skill. The options had smaller numbers, which could obviously not be the correct responses. For example, 510 cannot be the response to such a problem.

Figure 4. Children's Computation Estimation ability.

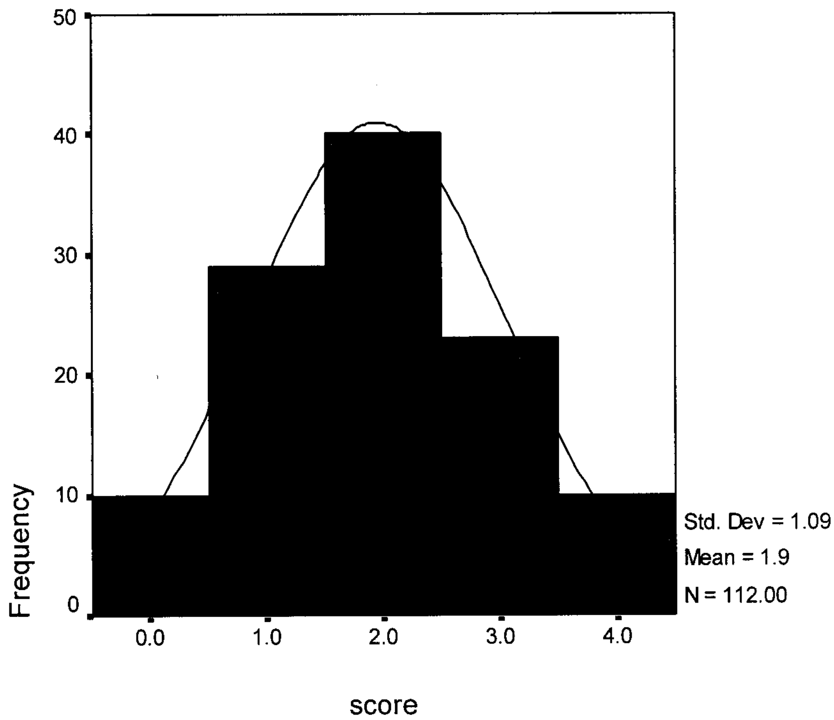


The graph above shows that most of the children had poor estimation skills. It can be seen from the graph that most of the scores are below fifty percent. About 78% of the children had scores less that half of the total.

Mathematical Word-Problems

This subtest required that children read a mathematical problem and find the appropriate response from the given options. Figure 5 below shows the findings of the present study.

Figure 5. Mathematical Word-Problem



The subtest had a total of four questions, each of them carrying one mark. From the graph above, it is clear that only a small number of children were able to get all the problems correct. Most of the children had only two correct. It is clear about 70 % of the children scored at or below half of the total score. It can be seen from the graph that ten children had a score of zero in this subtest.

Principles of Calculation

Children were given several tests to assess their ability to use correct principles of computation to arrive at an answer. There were nine items that assessed this skill. Each item carried one mark and the total for all the times was nine. The results are presented in figure 6 below..

Figure 6. Children's Ability to Apply Principles of Calculation

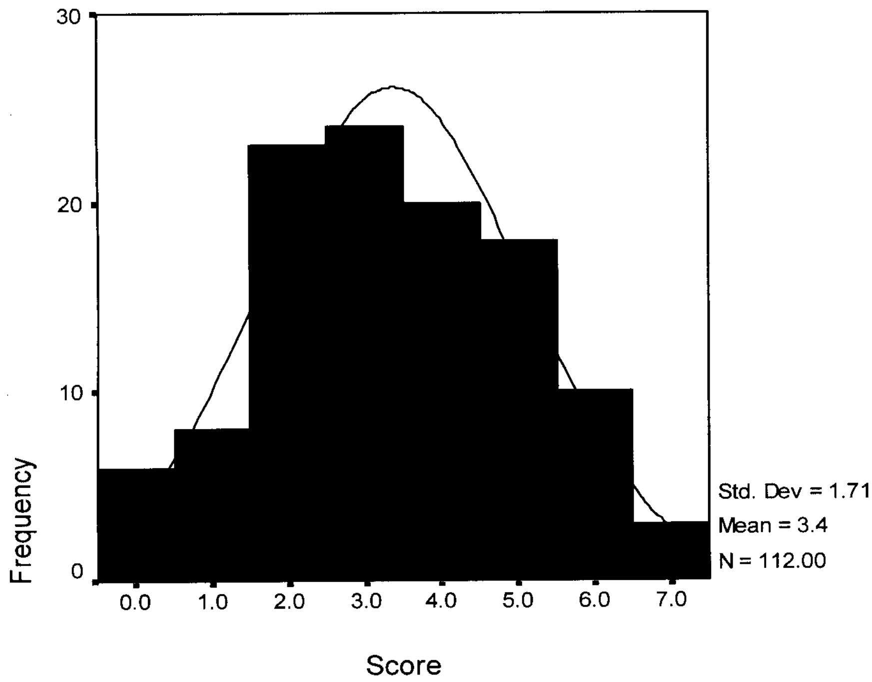
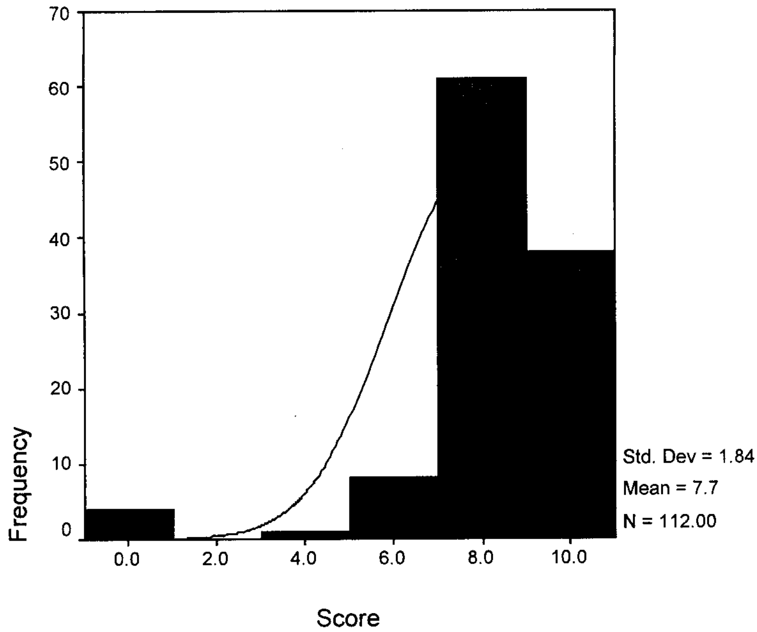


Figure 6 six shows that most pupils, 83.93 % (94) had scores falling below half. Only about 16 % (18) of the children showed an understanding of computational principles at half or better. None of the children were able to get all the problems in test subtest correct.

Identification and Understanding Number Place Value

In this test, children were required to identify numbers and show an understanding of number place values. This skill is important for accurate computations and awareness of numbers. Unless one can identify the position and the value of a number, it will be unlikely that one will get the correct answer. Figure 7 below shows the performance of the children in this subtest.

Figure 7. Ability to Identify and Understand Number Place Values



The graph shows an increase in the number of children scoring high marks. Most children were able to identify numbers and number place values. There was, however a small group that did not get any item in this subtest correct in this subtest. About four of the participants could not identify numbers and correctly identify number place values.

Correlation between Specific Mathematics Skills and ZAT-M Total.

The results from the individual subtests were correlated to investigate the relationship between specific mathematical skills and the performance on the ZAT-M total score. The correlations are presented in table 7 below:

Table 7. Correlation of ZAT-M Total and Specific Mathematical Skill

	ZAT-Accuracy	ZAT-Fact	ZAT-Comp	ZAT-Story	ZAT-Principle	ZAT-Num
ZATTOT	0.62**	0.57**	0.41**	0.46**	0.64**	0.52**
Accuracy		0.54**	0.37**	0.36**	0.55**	0.49**
Fact Retrieval			0.20**	0.36**	0.43**	0.43**
Estimation				0.25**	0.35**	0.38**
Story Problems					0.40**	0.34**
Principles						0.44**
Place Value						

** Correlation is significant at p< 0.01, (2-talied). (The probability of these correlations to occur by chance is less than 10 %)

Note: All the correlations presented above are from the subtests of the ZAT-M
Accuracy=Accuracy on number computation; **Fact**=Automatic Fact retrieval; **Comp**= computational Estimation; **Story**=Mathematical Story Problems; **Principle**= Understanding principles of calculation; **Num**= Place value and number identification.

The correlations above seem to be in agreement with previous studies. The correlations on each of the subtests with the total score on the ZAT-M were statistically significant. An observation of correlations within the skills seems to have positive correlations but the strength of the significance differs from one test to another. It can be observed from the table above that there is a positive correlation between the specific skills for mathematics and the total score that the children obtained. The highest correlation was between the total and understanding principles of calculation (r= .64, p<0.01) and the lowest correlation noted was the correlation between the ZAT-M total and computation estimations (r=0.41, p<0.01).

Performance of the Children on the Universal Non-verbal Intelligence Test (UNIT)

Each participant was required to take an intelligence test. One of the subtests in the UNIT assessed the children's ability to recall from memory symbols that were presented to them for five minutes. The test is called the Symbolic Memory (***SyM***) subtest. The second test assessed the children's problems solving skills. They were presented with a diagram which they had to reproduce with cubes that were handed to them this test is called the Cube Design (***CD***). The last subtest under the intelligence test assessed the children's ability in spatial tasks. This was through the Spatial Memory (***SpM***) Subtest. The results of the study are presented below.

Children's performance on Symbolic Memory

In this subtest, the children were required to view five chips with symbols of a man, woman, boy, girl and baby for five seconds. There were two sets of colours, one set was green and the other was black. Then these are covered and the child is expected to recreate sequence using the response cards provided. There were thirty (30) items in this subtest.

The performance of the children in the urban and rural schools is presented in figure 8 below.

Figure 8. Children's performance on Symbolic Memory by Sex and Area of Participant

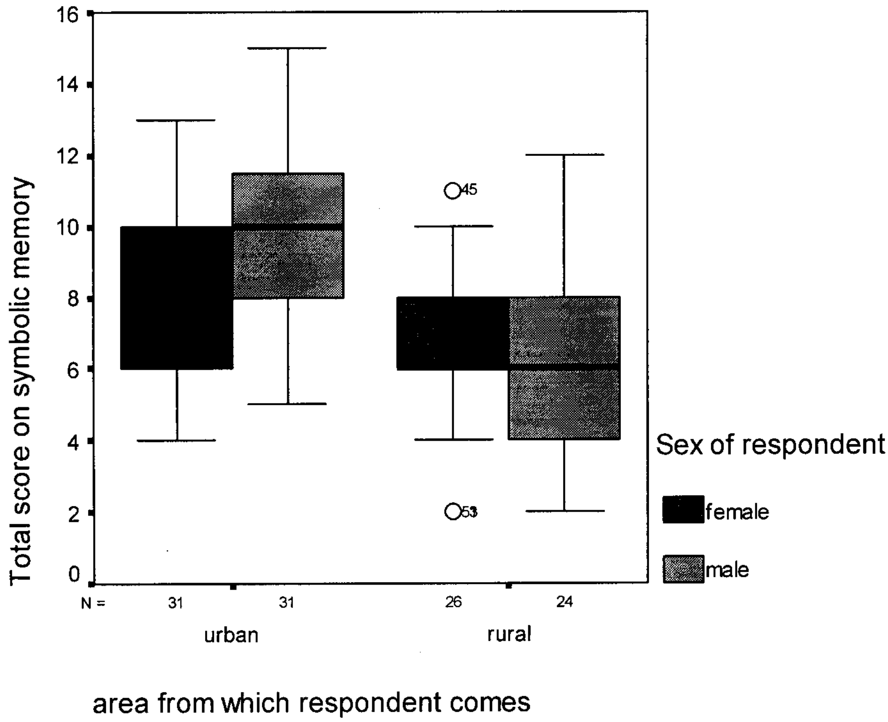


Figure 8 shows a consistent difference in performance between the urban and rural participants on the Symbolic Memory subtests of the UNIT. The mean score for participants in the urban schools was 8.97 (SD= 2.76) while that of the rural schools was 6.52 (SD=2.57). It can be observed that the males (mean=6.58, SD=2.99) in the rural schools generally performed poorer than the females (mean= 8.13, SD= 2.65) in the urban schools. When subjected to the analysis of variance, the mean differences between the urban and the rural participants reached statistical significance level. *(F (1,109) 23.92, p<0.01).* These results suggest that the participants in the urban schools generally performed better than the participants in the rural schools.

Children's Performance on the Cube Design

While viewing the figure on a page, the child is required to reconstruct the design within a specific time limit using cubes coloured in green and white. This subtest consists of fifteen (15) items each carrying one mark. The findings are presented in figure 9 below.

Figure 9. Performance on the Cube Design by Sex and Area of Participant

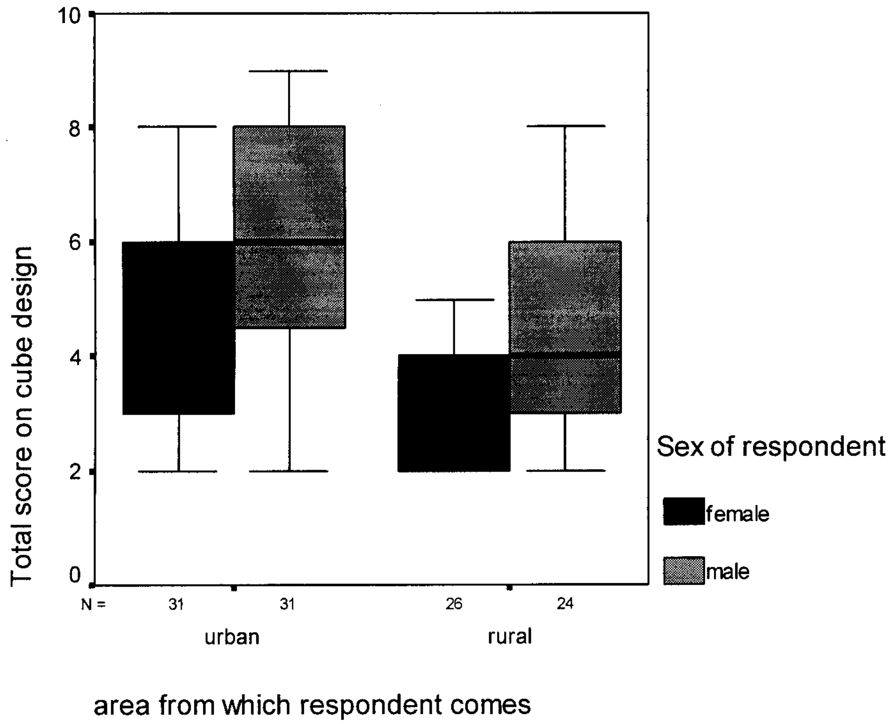


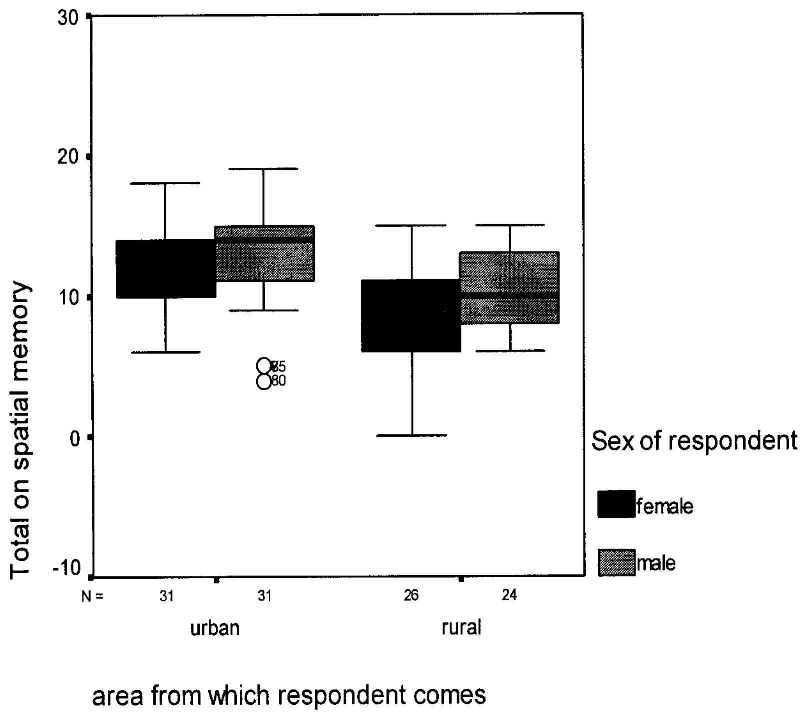
Figure 9 presents the performance of the children on the cube design subtest of the unit. The maximum score for the male participants in the urban schools was 9 while the maximum score for the males in the rural was 8. The maximum score for the females was 8 in the urban schools, while the maximum score for females in the rural schools was 5. The mean scores for the urban were 4.74 (SD=2.06) for the female participants and 6.29 (SD=1.99) for the males. The males in the rural schools had a mean of 4.46 (SD=1.79) while the females had a mean score of 3.15(SD=1.05). The test for significance of the rural and the urban mean differences reached statistical significance level ($F(1,109)=25.2, p<0.01$). Analysis of variance between the male and female participants reached statistical significance of $F(1,109)=18.16, p<0.01$).

Children Performance on the Spatial Memory Subtest.

The spatial memory subtest required a child to view a pattern of green and white chips on specific locations of the page for five (5) minutes. The child is then expected to re-create the pattern by placing the chips on a response grid provided. There are twenty-seven (27) items each one carrying one mark.

Figure 10 below presents the performance of children in the spatial memory subtest.

Figure 10: Performance of Children on the Spatial Memory by Sex and Area of Participant



The figure above shows that the males in the urban schools performed better (mean score = 12.67, SD=3.58) than the males in the rural schools (mean score=10.25, SD=2.75). The females mean score in the urban schools was 11.77 (SD=3.31), while the mean score for the females in the rural schools was 8.66 (SD=3.19). When the results were subjected to the analysis of variance, the difference in mean score for the urban and the rural participants reached statistical significance level (F (1,109)=4.02,p<0.05). The mean difference of the male and female participants in the Symbolic Memory subtest also reached statistical significance level. (F (1,109) =20.64, p<0.01).

Correlation between the Achievement Tests and the Intelligence Test

The total score of the mathematical subtests were correlated with the performance on the Universal Non-verbal Intelligence test using the Pearson's correlation coefficient test and the results are presented in table 8 below.

Table 8. Correlation of ZAT-M, G5NA and the UNIT

Test	Correlation with	Correlation co-efficient (r)
UNIT	ZAT-M	0.33
	G5NA	0.44
G5NA	ZAT-M	0.45

The correlation was significant at p<0.01 level

The results of the correlation analysis suggest that there was a significant correlation between the performance of the children on the ZAT-M, G5NA and the cognitive tests. These findings seem to suggest that the children need to have sufficient memory, visuospatial, and problem-solving skills in order to do well in mathematics. The highest correlation coefficient was observed from the UNIT and the G5NA test r=0.44 compared to the correlation coefficient of ZAT-M which was r=0.33. The significance level in this analysis was at the level of *p<0.01.*

The results of the study seem to indicate that the prevalence of Mathematical Difficulties among Grade 5 pupils in Lusaka Province is within the estimated prevalence in most studies.

lence seemed to range from 3.6% to as high as 7.3%. It can be observed from the esented in this chapter that performance of the children is influenced by the schools h the child comes. While the mean scores from the location of the school and the sex d seem to have differed, statistical analysis of the strength of the mean differences did statistical significance.

has further been observed from the results that the nature of MDs is varied in children. culties that children face during mathematical computations are diverse. Some have fact fficulties while other children have a procedural deficit. Another group of children o have been facing difficulties with word problems and principles of mathematics. ildren had problems with identifying numbers and understanding number place values.

CHAPTER 5

DISCUSSION OF STUDY FINDINGS

This study set out to investigate the prevalence and nature of mathematical difficulties among grade five pupils in Lusaka Province. The study assessed the skills of 112, fifty-seven (57) females and fifty-five males as shown in table 1 on page 20, participants from Lusaka Urban and Rural schools. The mean age for the sample was 11.75 years with the oldest pupil in the rural school and the youngest from the urban school.

This chapter presents the discussion of the findings in the previous chapter. This discussion begins with a highlight on the major findings of the study.

Prevalence of Mathematical Difficulties

The prevalence of MDs in the whole sample was found to be as high as 4.5% on the ZAT-M and 3.6% on the G5NA. The findings in this study are below the 6.4 % estimates given by Kosc (1974) and Badian (1983). However, the prevalence on the ZAT-M is more than those found by Lewis et al. (1994) of 3.6 % while the prevalence on the G5NA is consistent with the study by Lewis et al (1994). The difference in prevalence from the different tests is not surprising as this is expected in most researches that when different tests are used to measure a given skill, the results are likely to differ.

With regard to the G5NA, there is an interesting shift in the prevalence. The prevalence of MDs in the urban sample is the same while that for the rural sample increases to as high as 6.3 %. The difference in prevalence at this stage could be due to the fact that the differences in mean, change the point at which the number of children are

ed to be experiencing mathematical difficulties. For instance, the means for the
d rural samples are different due to the different individual scores that make up
nated mean and standard deviation from which the cut-point is derived.

Another plausible explanation to this shift in prevalence may be due to the fact he ZAT-M, the questions are read to the participants, where as the participants ead the problems themselves in the G5NA. Participants who may be experiencing difficulties may have faced problem in solving the problems presented to them. the children in the rural schools do not get as much exposure to reading materials hildren from urban schools. Sternberg (1994) notes that major responsibilities of outside schooling may compromise their ability to benefit from school. Secada reviewed research on social class disparities in pre-school children's arithmetic, ncluded that many poor children enter school at an academic disadvantage to their class peers.

of Mathematical Difficulties

he findings in the present study, children experienced different kinds of difficulties ematics some of which are discussed below.

cy on Number Calculation

In this task children were required to compute simple numbers in order to arrive at ion. They were given several options from which they had to select the appropriate . Some of the questions asked included basic addition, division multiplication and ction problems. Examples of such questions are:

Question 21. 7-2=______

Question 26. 24+36=____

Most of the children (58%) seemed to have had no problems computing the responses to these questions. The findings from the study seem to suggest that most of the children in fifth grades are able to carryout accurate computations. However, it is clear that not all the children were able to compute accurately. Some children showed that they did not understand what minus meant. They would add the numbers when they should have subtracted and subtracted where they should have added. For example, question 21 of the ZAT-M asked the children to subtract 2 from 7. The correct response would be five. However, nine children (8%) gave a response of 9. This would mean that the children added 2 and 7 instead of subtracting. It appears that some children with MDs can get facts into and out of long-term memory without too much difficulty but have trouble inhibiting other facts when they try to remember the answers to specific problems, such as 2+3. These children will not only remember 5, they would also have 4 (the number following 2 3 in the counting sequence) and 6 (the answer to 2x3) pop into their heads at the same time. With too many facts being remembered, these children take longer to remember the correct answer - they may have to consider all of the answers that they remembered and then pick one of these - and they make more errors.

The general picture as seen from Figure 2, on page 30, is that children have developed basic skills for accurate computation though there are children within the sample population that seem to have problems with accuracy in their computation.

Mathematics Fact Retrieval

The participants were given a test to assess how well and fluently they would recall facts about mathematics. There were ten questions that were assessing this skill.

igure 3, page 31, presents the performance of the children on this test. The figure lustrates that most children were able to remember mathematics facts.

Further analysis of the specific performance of the children indicates that children re experiencing various types of difficulties.

Question 15 in the ZAT-M required the children to state what number would omplete the sequence of numbers 3, ____, 5 (see Appendix 1). The correct answer was . A total of 69% of the children were able to give the correct response. There were some hildren who did not see the sequence and added the two numbers. A total of 10% of the articipants selected 8 as the correct response to the question.

Another question required the children to state what percentage one half (1/2) vould be equivalent to. The results show that only 61% of the children were able to espond correctly to this question.

In another problem question 32, the children were asked to complete the sequence f 5, 10, ___, 20. The results showed that 52% of the children were able to select 15 as ne number missing in the sequence. However, 23 % were unable to give the correct esponse. They selected the number 11 as the next in the sequence. These results seem to ndicate that children are not able to recall basic mathematics facts. The study findings re consistent with the findings of Jordan and Hanich (1998) that children with nathematical difficulties have problems recalling basic mathematical facts. It does, owever, seem that mathematics fact retrieval difficulties have effects beyond tasks that mphasize such facts, and spill over into other areas of mathematics. If people have rouble in remembering basic arithmetic facts, then they will have to calculate these facts y alternative and usually more time-consuming strategies. Even if they are able to do so accurately, it means that they must devote time and attention to obtaining facts that someone else might retrieve automatically; and this will divert time and attention from other aspects of arithmetical problem-solving, resulting in lower efficiency (Dowker, 2004).

Computational Estimates Skills

Some mathematics problems require that one estimates the nearest correct answer without having to go through the process of long multiplication, addition, division, or subtraction. The ability to estimate the product or sum of large numbers can also help a student when they take timed tests. It is therefore important that one is able to make accurate computational estimates in a given problem.

The participants in this study were given eight questions that assessed their ability to make computational estimates. Only about 21 (18%) of the participants were able to estimate the value of numbers. The findings of the study suggest that most of the children had problems estimating the value of computation. The findings of this study are consistent with the work of Jordan et al. (2003) who studied the performance of children with and without mathematical difficulties and found that the MD group had more problems of calculation estimations than did the group that had normal mathematical skills.

Mathematical Word Problems

A major argument for the inclusion of mathematical story problems is to develop the skills of children in applying mathematical knowledge to real life situations. In this ıdy, the children were given several story problems that they had to understand and terpret in order to arrive at the correct answer. The performance of the children in gure 5, page 33 shows that most of the children had average performance on this task.

Performance on this task may mean that children are not able to apply their athematical skills to the real world. An example of the story problems presented to the ildren is question 60 of the ZAT-M.

lary had 100 eggs to sell. She sold 87%. How many eggs does she have left? Answer: 13.)0-87)

A total of 38 or 33% of the children answered this problem correctly. Another % of the children selected 87 as the number of eggs that Mary had. This performance uld indicate that the children had difficulty understanding what the problem was asking r. These findings are consistent with research on the performance of children on athematics story problems in Ostad (1998), Jordan and Hanich (2000), that children thout MDs perform significantly better than children with MDs. The performance of ildren on this test shows that the children seem to have had problems with applying eir mathematical skills to real life situations through the story problems. Perhaps the ost plausible explanation is that children have not reached a sufficient proficiency to derstand that the principles that they have learnt in school can be applied in real life to ıd solutions to mathematical problems.

pplication of Principles of Calculations

There were nine questions that were assessing the ability to use principles of lculation. The results in Figure 6, page 34, seem to suggest that more than 50% of the children had less than half of the problems correct. Only a few of them were able to apply the principles of calculation to their problem solving strategies, two of the participants had seven out of nine problems correct. Table 6, page 28, shows that there is a very high correlation between the child's ability to apply correct principles of calculation and the total score on the ZAT-M. These findings could be interpreted to mean that the more children fail to apply the principles of calculation to the mathematics problem solving, the poorer their overall performance will be on mathematical tests. An example of the problems the children were faced with was question 52 of the ZAT-M where the children were asked to divide 160 by 20. 0nly 17(16%) of the children got this problem correct. The rest were not able to understand that 160/20 is the same as 16 divided by 2.

The findings of the study indicate that most of the participants had not mastered the principles of calculation. It may also be possible that the children had not been taught the principles that govern mathematical calculation. If this is the case, then the children are lagging behind in mathematical skills, as they should have mastered these skills at grade five level.

Table 7, on page 36, shows that there is a significant correlation between the specific mathematical skills and the total score on the ZAT-Mathematics. There were high correlations between the pupils' accuracy on mathematical computations, principles of calculation and the total score on the ZAT-M. These findings are consistent with literature on the importance of having adequate skills for computation and good skills for understanding the principles of calculation (Dowker, 2004)

Ability to Identify Number and Number Place Value

Unless a child is able to identify numbers and their values in a given problem, they will not be able to place the number in the correct location and therefore may not be able to carryout the correct computations. The participants of this study were given ten questions to assess their ability to identify numbers and place values.

Figure 7, page 35, shows that most of the children were able to identify numbers and understand the place values of numbers in a given problem. A few of the participants seemed to have had problems in this area and scored poorly. It can be concluded from these findings that grade five pupils in the study generally have adequate number identification skills. There are some, however, who were facing problems with this skill. This could be attributed to the fact that number identification is the most basic skill that children have and it is drilled in class at an early stage. In the first grades of schooling, the children are drilled in number identification.

The performance on the Universal Non-Verbal Intelligence test is consistent with research on the performance of females compared to males. The performance as can be seen in figures 8, 9, and 10 shows that males consistently performed better than the females in the urban area and the same picture can be seen in the rural area where the males performed better in the UNIT than the females. However, there is a pattern that shows that females in the urban area have a higher mean score than did the males in the rural area. The results apparently favour the hypothesis that children in the urban areas perform better than children in rural areas because they have exposure to toys and activities that give them superior skills in intelligence tests.

The findings of the study on the prevalence of mathematical difficulties in the general population show that there is no difference in the urban and rural samples when the same mean is used to estimate the prevalence. The prevalence of MDs was 4.5 % of the whole sample.

The general performance of the participants in this study seems to indicate that children from rural schools scored lower than children in the urban schools. Further examinations of the participants on specific tests suggest that the children in the rural schools are at a disadvantage compared to their peers who are in the urban schools.

From the results of this study, it can further be noted that the mean score for the females in the urban schools was higher than that of the males in the urban and the rural schools. An examination of the results from each school reveals that the participants from the female single sex school (Lusaka Girls' School) had the highest mean score than all the other schools in both the ZAT-M and the G5NA tests. This could be attributed to the fact that most of the female pupils in this school were from affluent backgrounds. Most of the children had televisions, where they may have been exposed to further mathematical instruction. Another possible explanation to this difference in performance could be that Lusaka Girls' seemed to have been adequately stocked with educational material. The other schools did not seem to have enough textbooks for the children. This is consistent with the a research that was done by Bottoms and Carpenter (2003) who investigated the performance of rural children in mathematics in which they observe that most or the schools in the rural areas fail to provide adequate learning materials and extra support for mathematics. This tends to disadvantage children who come from rural schools areas compared to those who come from urban schools.

The general performance of the participants of the study shows that children do better on a test in which the problems are read to them (ZAT-M) than they did in the G5NA in which they had to read the problems themselves.

This performance is not replicated in the intelligence tests. Table 4 on page 27, shows that the males in the urban schools had a higher mean score (27.71, SD=9.74) on the UNIT than the mean score of the females (24.65, SD=6.96) in the urban schools. The mean score for the males (19.75, SD=4.99) in the rural schools was higher than the mean for the female participants (18.15, SD=4.12) in the rural schools.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study was undertaken firstly to investigate the prevalence of mathematical difficulties in grade five pupils in selected schools in Lusaka. Secondly, the study aimed at investigating the nature of mathematical difficulties in children. Additionally, the study attempted to show whether there were differences in prevalence between males and females, and between urban and rural pupils. The most significant results are summarised below.

The results of this study provide evidence that the prevalence of mathematical difficulties in school children may be significant regardless of the children's social economic status. Estimation from this study would suggest that at least 40 children in every 1000 children would be experiencing difficulties in mathematics.

Secondly, it was observed that the participants experienced various types of difficulties in mathematics. It could be concluded that the nature of MDs in children is diverse. Some of the difficulties experienced were weaknesses in number computation, fact retrieval, computational estimation, understanding of word-problems, understanding of principles of calculation and number identification and place value knowledge.

Thirdly, the results suggest that the gender disparity of mathematical achievement is not consistent for every population. In the findings of this study, female participants from the urban schools performed better on both the achievement tests than did the males from both the urban and the rural schools.

Fourthly, it was observed that the performance of the children was generally better on the mathematical test where the questions were read to the children. This may give a better chance for children with reading difficulties to perform better than they would if they read the questions themselves. The current format of examination may be giving undue advantage to children who can read over those who may have good mathematical skills but are experiencing some problems in reading.

The fifth observation from the study was that the performance of children on the mathematical tests is to a large extent dependent on the child's ability to efficiently use the components that make up mathematical competence. For example, the child needs to have normal skills for accurate computation of numbers, automatic fact retrieval, computation estimation, ability to understand and transfer knowledge into real life situations, understanding principles of calculation and an ability to identify numbers and understand number place values.

Lastly, it was observed that visuospatial skills, memory skills and problem solving skills are important for good skills in mathematics. The correlations were statistically significant for each of these cognitive skills.

Recommendations

Based on the findings of the study, the following recommendations are made.

i. The Examination Council of Zambia may need to consider changing the format in which children are required to take mathematical examinations. The findings in this study show that children's performance on the test, in which the mathematical questions were read out to them, was better than the performance where the children had to read and understand the questions on their own. Geary et al. (1999) suggest that children with combined mathematical and reading disabilities tend to perform badly on more aspects of mathematics than children who only have mathematical difficulties.

ii. Teachers must be made aware of the different problems children face in carrying out mathematical tasks. The fact that children have different strengths and weaknesses in mathematical skills, different strategies need to be used to meet the individual difference of children. This could be achieved by including a component if individual differences in all teacher training programmes

Suggestions for Further Research

Future research could be undertaken to investigate the extent to which parental involvement in children's mathematical learning can help improve the performance of children in mathematics achievement.

Building on this study, research could be undertaken to assess the areas in which male students and female students have strengths and weaknesses.

Studies to establish the best practices for intervention for children with mathematical difficulties could be undertaken in future research.

Further investigations must be made to ascertain the extent to which mathematical difficulties exist in all schools in the country. This will give a more realistic estimation of the problem of mathematical difficulties children are experiencing and in turn, take measures to help children learn mathematics better. Mathematical Difficulties could be brought more into centre stage of research in learning difficulties.

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APPENDIX 1. Sample Questions from the Zambia Achievement Test-Mathematics

Computational Accuracy

$$\begin{array}{r} 49 \\ \underline{-24} \end{array}$$

9	37
16	25

ZAT-M-English 60

#30

Point to the math problem at the top of the page.

Say: **What does 49 minus 24 equal? Find the answer to the problem—*down here.***

Point to the area with answers.

Say: **Point to it.**

Answer: **25**

ZAT-M-English 61

687

x 13

8 931	718
674	510

#49

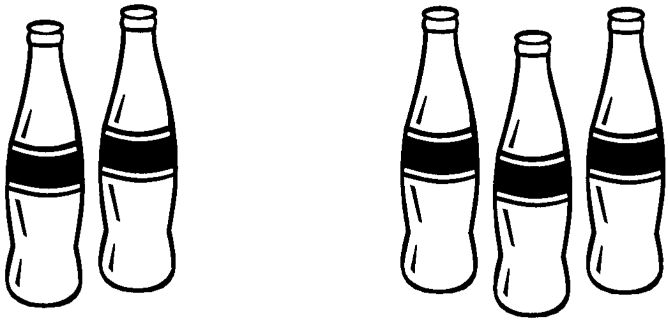
Point to the math problem at the top of the page.

Say: **What does 687 times 13 equal? Find the answer to the problem—*down here.***

Point to the area with answers.

Say: **Point to it.**

Answer: **8 931**



1	6
9	5

#15

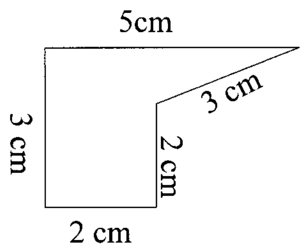
Point to the pictures at the top of the page.

Say: **Precious has two soda bottles. Her brother Simeon has three bottles.**

Point to the area with answers.

Say: **Point to the number that shows how many bottles they have together.**

Answer: **5**



26 cm	4 cm
15 cm	53 cm

#41

Point to the picture at the top of the page.

Say: **How many centimeters is it all the way around the shape? Find the answer to the problem—*down here.***

Point to the area with answers.

Say: **Point to it.**

Answer: **15 cm**

5	4
1	8

#4

Sweep your hand over the numbers on the page.

Say: **Which number here is the number five? Point to the number five.**

Answer: **Upper Left Corner**

$$\begin{array}{r} .6 \\ \underline{+.62} \end{array} =$$

.68	12.9
6	1.22

ZAT-M-English 110

#55

Point to the mathematical problem at the top of the page.

Say: **What does .6 plus .62 equal? Find the answer to the problem—*down here.***

Point to the area with answers.

Say: **Point to it.**

Answer: **1.22**

ZAT-M-English 111

MINISTRY OF EDUCATION

NATIONAL ASSESSMENT PROJECT

GRADE 5

NA/AMAT3/2003 **MATHEMATICS** **TIME: 60 MINUTES**

Read these instructions carefully.

DO NOT turn this page before you are told. Your teacher will tell you when to turn this page to begin the questions.

There are 45 questions in this **MATHEMATICS** paper. You will be given **EXACTLY 65 MINUTES** to do the questions.

For each question, four answers are given, but only one of the four is right. Work out which is the **BEST** answer.

When you have finished one page, go straight on to the next page without waiting to be told. If you have time left at the end of the question paper, use it to check your work carefully.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD.

IEMATICS QUESTIONS

$15 \div 3 =$

A 5

B 6

C 12

D 18

2 litres + 8 litres =

A 4 litres

B 6 litres

C 10 litres

D 16 litres

10 ☐ 15

A >

B <

C =

D

7 days =

A 1 week

B 2 weeks

C 1 month

D 2 months

$\frac{1}{2} + \frac{1}{2} =$

A 1

B $\frac{1}{2}$

C 0

D $\frac{2}{4}$

6 There are • • • seconds in one minute.

A 12

B 24

C 30

D 60

7 The number which comes next in the sequence 310, 410, 510, is • • •

A 610

B 620

C 710

D 720

8 How many K100 notes are in K1 000?

A 1

B 5

C 10

D 100

9 What is the ninth month of the year?

A July

B August

C September

D October

10 9 432 can be written in words as • • •

A nine thousand two.

B ninety four thousand thirty two.

C nine hundred nine thousand thirty two.

D nine thousand four hundred thirty two.

11 Forty divided by eight is equal to • • •

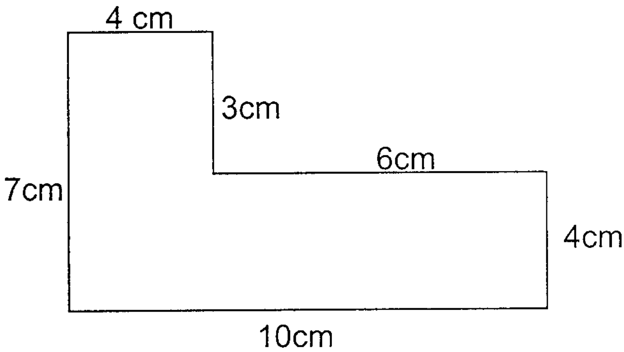
A 5

B 6

C 7

D 8

12 Find the perimeter of the shape below.



A 26 cm

B 34 cm

C 36 cm

D 90 cm

13 50 + 900 =

A 509

B 590

C 905

D 950

14 240 ÷ 20 =

A 48

B 26

C 22

D 12

15 What is the place value of seven in the number 7 546?

A Thousands.

B Hundreds.

C Tens.

D Ones.

16 Add 7 230, 5 281 and 1 346.

A 13 857

B 13 757

C 12 851

D 12 757

22 $12 \times 1\ 000 =$

A 12

B 120

C 1 200

D 12 000

23 Which of the following is true?

A $23 \times 8 = 8 \times 23$

B $23 \times 8 > 8 \times 23$

C $23 \times 8 < 8 \times 23$

D $23 \times 8 = 8 + 23$

24 The smallest unit used for measuring time is the …

A day

B hour

C minute

D second

25 One bag of maize weighs 55.4 kg. What will be the weight of 6 such bags of maize?

A 302.4 kg

B 330.24 kg

C 330.4 kg

D 332.4 kg

26 $9.45 - 7.12 =$

A 2.33

B 2.37

C 2.47

D 2.57

27 Which number must be put in the ☐ to complete the pattern?

2, 0, 3, 1, 4, 2, 5, ☐ , 6, 4.

A 2

B 3

C 4

D 5

28 3 500 metres is the same as • • •

A 3 km

B 3.5 km

C 30 km

D 35 km

29 Measure the length from X to Z in cm.

X  Z

A 4.5 cm

B 4 cm

C 5 cm

D 7 cm

30 Red is a member of the set of colours. This can be written as • • •

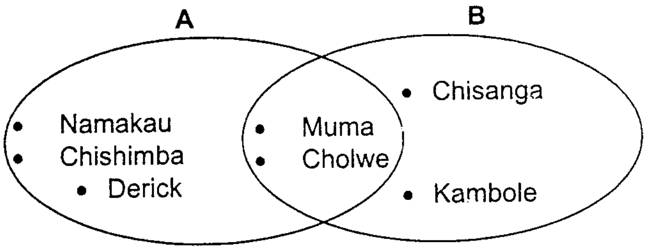
A Red = {colours]

B Red ∈ [colours]

C Red ⊂ {colurs}

D Red ∉ {colurs}

31 Look at the sets A and B below. The number of members in set B is • • •



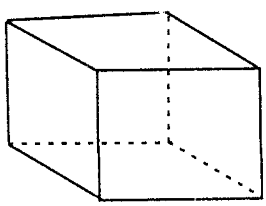
A 2

B 3

C 4

D 7

32 The number of faces in the figure below is • • •



A 4

B 5

C 6

D 7

33 How many classes of 25 children each can be made from a total of 200 children?

A 8

B 80

C 175

D 5 000

34 *Mr Katongo bought a shirt at* K6 550. How much change did he get from *K10 000?*

A K3 350

B K3 450

C K4 450

D K4 550

35 The cost of a bus ticket from Lusaka to Kabwe is K5 500. How much will 10 tickets for the same journey cost?

A K55 000

B K10 550

C K5 510

D K5 490

36 4.009 litres – 3.997 litres =

A 1.120 litres

B 1.112 litres

C 1.012 litres

D 0.012 litres

37 A ball is an example of a • • •

A sphere

B cylinder

C cone

D circle

38 The tank of a lorry holds 150 litres of diesel when full. If the tank is ½ full, how many litres of diesel are in the tank?

A 70 litres

B 75 litres

C 152 litres

39 The unit of mass is • • •

A kilometres

B kilograms

C centimetres

D millilitres

40 How many halves are there in two?

A 1

B 2

C 3

D 4

41 The product of 9 and 8 is • • •

A 1

B 17

C 72

D 98

42 Find the difference between 86 775 and 95 000.

A 8 225

B 8 325

C 8 235

D 9 235

43 Which of the following months has 31 days?

A February

B March

C April

D June

44 $\frac{4}{10} + \frac{6}{10} =$

A 1

B 2

C $\frac{10}{20}$

D $\frac{46}{100}$

45 *A boy watched $\frac{1}{4}$ of his local team's games. If his team played 56 games, how* many games did he watch?

A 14

B 16

C 52

D 56

STOP, PLEASE GO BACK AND CHECK YOUR WORK