EFFECTS OF GUIDED DISCOVERY AND MODEL-LEAD-TEST STRATEGIES ON QUANTITATIVE REASONING SKILLS OF PUPILS WITH LEARNING DISABILITIES IN UYO, NIGERIA

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CERTIFICATION

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DEDICATION

This work is joyfully dedicated to my beloved family – my beloved wife Veronica and my children Theresa, Sweet man and Solace for their unwavering love and support throughout the period of this programme

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> "… The race is not to the swift nor the battle to the strong, nor bread to the wise … (Eccl. 9:11). So then it is not of him that willeth nor of him who runneth, but of God that showeth mercy (Rom. 9:16)

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ABSTRACT

Quantitative Reasoning Skills (QRS), the ability to apply basic mathematical skills to solve practical life situations, are essential for successful schooling and survival in the society. However, many Pupils with Learning Disabilities (PwLD) in Uyo, Nigeria have low QRS, which partly accounts for their poor performance in mathematics and other life vocations. Previous studies concentrated more on the problem of teaching reading and development of strategies for improving reading skills among PwLD than on intervention to improve their QRS. This study, therefore, was carried out to determine the effect of Guided Discovery Strategy (GDS) and Model-Lead-Test Strategy (MLTS) on QRS of PwLD in Uyo, Nigeria. The moderating effects of gender and mathematics anxiety were also examined.

The study was anchored on information Processing Theory, while the pretest-posttest control group quasi-experimental design, with a 3x2x3 factorial matrix was adopted. The multi-stage sampling procedure was used. Three Local Government Areas (LGAs) were randomly selected from the nine in Uyo, while three primary schools with high student enrolment were purposively selected (one from each LGA). Initial screening involved teacher nomination of underachieving primary five pupils in the classroom. Sixty PwLDs were selected after further screening using the Slosson Intelligence Test and the Pupil Rating Scale. The schools were randomly assigned to GDS (20), MLTS (20), and Control (20) groups. The instruments used were Slosson Intelligence Test (r=0.74), Pupils Rating scale (0.90), Mathematics Anxiety Scale for Children (r=0.92), Quantitative Reasoning Deficit Scale (r=0.88) and Quantitative Reasoning Achievement Test (r=0.75). Data were subjected to descriptive statistics, Analysis of covariance, and Scheffe Post-hoc test at 0.05 level of significance.

The majority of the participants (57.0%) were female, and 62.0% had high mathematics anxiety. There was a significant main effect of treatment on QRSs ($F_{(2;47)}$=17.67; partial η^2=0.43). The participants exposed to GDS obtained the highest mean score (49.86), followed by those in MLTS (44.41) and those in the control group (32.05). There was a significant main effect of gender on QRSs ($F_{(2;47)}$=9.34; partial η^2= 0.00) in favour of males in GDS. There was a significant main effect of mathematics anxiety on QRSs ($F_{(2;47)}$=7.97; partial η^2=0.02). The participants with low mathematics anxiety had a higher mean score (39.62) than those with high mathematics anxiety (28.21). There was a significant interaction effect of treatment and mathematics anxiety on QRSs ($F_{(2;47)}$=8.84; partial η^2=0.08). The interaction effect of treatment and gender; gender and mathematics anxiety as well as the three way interaction effects were not significant.

Guided discovery strategy, more than model-lead-test strategy, enhanced quantitative reasoning skills of pupils with learning disabilities in Uyo, Nigeria particularly among those with low mathematics anxiety. These strategies should be adopted by teachers in order to enhance quantitative reasoning skills of pupils with learning disabilities.

Keywords: Instructional strategies, Mathematics anxiety, Mathematics disability, Quantitative reasoning skills, Pupils with learning disabilities.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The essence of education is for learners to acquire relevant skills, both soft skills and hard skills. Quantitative reasoning is one of the soft skills that are relevant for survival and success in everyday life. It is a skill that individuals, institutions and employers of labour sought for in school leavers, graduates and potential employees. It equips young people with critical thinking and problem-solving ability among other things. Quantitative reasoning leads to mathematical reasoning which ultimately leads to critical thinking skills. Hence in recent time entrance examinations and aptitude test conducted by many institutions of learning and hiring companies are largely based on quantitative reasoning. Besides the initial entry qualifications, prospective candidates for employment or admission into higher institutions of learning are expected to possess among other things high quantitative reasoning skills.

Interestingly, aptitude test is used nowadays to ascertain the level of quantitative reasoning skills of prospective candidates, which will enable them function optimally in their chosen course of study or career. Every student with or without disability, requires quantitative reasoning skills to successfully complete primary, secondary and higher school and to make meaningful contribution to the development of the society to which they belong. Hence the need for quantitative reasoning skills among pupils enrolled in primary school is becoming glaring by each passing day. All primary school pupils, secondary and tertiary institution students irrespective of their choice of career require good quantitative reasoning skills. People of all professions and vocations need quantitative reasoning skills, not only for their workplace but also to become productive members of a democratic society.

Quantitative reasoning skills, however, transcend beyond the simple mastery of mathematical computation and problem-solving. Using numerical, statistical, and graphical information regularly and in the workplace requires a comprehensive understanding of quantitative information. Individuals engaged in both skilled profession-like pharmacists, nurses, doctors, engineers and so on need proficiency in quantitative reasoning skills. For assessments as well as for problem-solving in general, quantitative reasoning requires the use of mathematical content. Those in semi-skilled and unskilled industry likewise require quantitative reasoning skills even the housewife for instance requires proficiency in quantitative reasoning skills to run the home. With such skills she would be able to know how to always half, double or triple recipes consisting of measures such as 1½ cups, 1¼ teaspoons and so on. It is crucial to prepare budgets for household expenses such as food and other items. This may require comparing cost, cutting down the cost of some items and deciding which item to buy and which not to buy. All these situations demand ample quantitative reasoning skills.

Primary school's quantitative reasoning curriculum prepares pupils, especially those with mathematics disabilities, for everyday life skills such as recognizing and using money. Mittler (2015) referred to this curriculum as empowerment curriculum which provides pupils with opportunity to make appropriate decision on types of toys to play with and graduating to choice of friends, work, leisure and later choice of partner. According to Olunloyo (2012) quantitative reasoning does not only equip the child with knowledge to pass common entrance examination and aptitude test but also for the child's intellectual development. It enhances the child's ability to solve problems from different dimension with little or no assistance. Teaching quantitative reasoning makes learning generally easier because quantitative reasoning skills elaborate the thinking faculty of the learner (Olayiwola, Ugochukwu, Wayas, Fadiya and Mohammed, 2013).

Once a student has acquired skills, Mortensen, Mclaughlin, Neyman, and Girshick (2013) noted that he or she could estimate the number of items that must be added, subtracted, divided, or multiplied to reach a certain number. The ability to use quantitative reasoning skills is attributed to the capacity to perform multiplication, division, addition, and subtraction operations fluently. There is a common misconception that quantitative reasoning (QR) and mathematics are synonymous. However, Davidson and Mckinney (2011) noted that quantitative reasoning and mathematics are, to some extent, complementary, but there are some significant differences between the two.

Quantitative reasoning differs from mathematics in the sense that, it is the capacity to reason quantitatively within real-life contexts which impact the leaners lives in practically. Quantitative reasoning equip learners with deductive reasoning, critical reasoning skill, problem-solving skill, logical reasoning skill and conceptualization. Quantitative reasoning is therefore primarily a skill, whereas mathematics is primarily a discipline that offers the knowledge of number sense, numeracy, computation, formulae and mathematical operations. While being a mathematician can be much fun, students need to possess the ability to use quantitative reasoning skills as part of their daily routine. For example, quantitative reasoning provides students with a solid understanding of compound interest and percentages, assessing the accuracy of statistical data and applying logic and rhetoric in real-life situations (Davidson & Mckinney, 2011). Additionally, quantitative reasoning is inclusive, its language plain, and it often has everyday applications, whereas mathematics is frequently exclusive.

Earlier researchers like (Ebiotu, 2012; Anyichie and Onyedike, 2012; Juma, Aloka, and Nyaswa, 2018) had focused on improving mathematics performance among school population, but the ultimate link which is quantitative reason skill seems to be missing. This missing link may have accounted for the persistent and increasing poor performance in mathematics among school children shedding light on the necessity of quantitative reasoning skill in primary school today. Twigg (2005) provided the philosophical approach to learning quantitative reasoning, stating that "students learn to acquire skills for solving quantitative reasoning by engaging in analytical reasoning." Any effective teaching of quantitative reasoning requires an innovative pedagogy – applying concepts to a real-life situation, emphasizing concepts over facts, and connecting content across disciplines (Cuban, 2011). Burkhardt (2015) argued in favour of problem-solving-based numeracy, arising from the fact that school pupils perceive mathematics as an insignificant subject with no connection to their everyday lives.

Karim and Wakefield (2010) stressed the need for practical examples to be presented before introducing more general theoretical concepts. These techniques for quantitative reasoning instruction play an essential role because the contextual use of numbers is fundamental to quantitative reasoning (Trimble & Mckinney, 2012). Moreover, Lagerlof and Seltzer (2008), Poze and Stull (2006) opined that traditional remedial mathematics pedagogies have failed to improve students' performance. It is therefore imperative that quantitative reasoning instruction be taken seriously by both pupils and teachers. Pupils that are properly equipped with quantitative reasoning skills do not only do well in school but become better citizens that make both cognitive and economic contributions to their society. The ability to think quantitatively obviously plays a central role in childhood education and adult life.

Enumerating the importance of quantitative reasoning skills Okafor and Anaduaka (2013) stressed that every individual irrespective of job or profession require quantitative reasoning skills to function effectively and efficiently within the society to which they belong. It is so because the complexity of the society confronts everyone daily with varied needs for quantitative reasoning skills. Obviously, quantitative reasoning skill is important for all school pupils and the new primary school curriculum is not mistaking about it. Awofala and Awolola (2011) opined that primary school curriculum is designed to develop in learners' generic skills such as critical thinking, problem-solving, logic and deductive reasoning. Generic skill is defined in terms of macro and micro skills. The macro skills include quantitative reasoning skills, problem solving skills, communication, inquiry, conceptualization and information technology while the micro skill include computation, mental calculation and estimation. Where these skills are lacking or poorly learned the result is poor performance or outright failure in school. Students' performance in mathematics over the years seems to be poor, with a high failure rate in examinations, as observed by Awofala (2012), further supporting the claim that school mathematics achievement is below society's expectations.

Students' failure in mathematics is becoming so alarming that researchers such as Rocconi, Lamber, McCormick and Sarraf (2013), Heward (2013) and Chen (2014) have traced the problems to the insufficient professional development of teachers in quantitative reasoning skills. In the opinion of the Organization for Economic Co-operation and Development [OECD, (2009)], this has led to dwindling mathematical literacy among school population. Mathematical literacy is understanding and using mathematics appropriately for one's needs (OECD, 2009). Many primary school pupils seem to have problems with mathematics probably because they think that the subject is abstract, it is hard to understand, worse still, mathematics teacher most times appear in class with a long cane without any hesitation to use it on any uncooperating pupil. For pupils with mathematics disability the mere mention of mathematics sends cold shivers of fear and panic down their spine. It is easy to see the struggle that can be involved in the subject. For pupils with mathematics disabilities, it is a nightmare, but if they can master quantitative reasoning and apply it to solving mathematics their problem would be reduced drastically and eminent improvement would be in sight.

The United Nations (2007) observed that pupils with mathematics disability normally have difficulty learning the basic aspects of mathematics skills. The difficulties lie in receiving, comprehending, and producing quantitative reasoning and spatial information. A child with mathematics disabilities (dyscalculia) has difficulty understanding simple number concepts, has difficulty grasping numbers intuitively, and has difficulty learning number facts. Cognitive and language abilities of most children with mathematics disabilities are within "normal" limits. They can excel in subjects other than mathematics. These pupils cannot understand what mathematics process to use with any given problem because they have difficulty with mathematics skills. Time and money measurements are difficult for them, and they are constantly unable to organize objects logically. Armes (2011) often describes children with this difficulty as having "number blindness".

Due to all the computation directions involved, students with mathematics disabilities experience directional disorientation when doing long division, multiplication, fractions and equations. Mathematical terms such as numerator, denominator, product, sum and others are often unclear to students with mathematics disabilities (Morin, 2014). Although students can learn other subjects quickly, they struggle to memorize basic facts (Newman, 2017). Mathematics disabilities can be identified and remedied with early intervention, which increases pupils' chances of staying on track or remaining motivated to learn mathematics skills. Learners with mathematics disabilities need proper identification, as Jacobson (2017a) explained since they need additional support to keep up with math classes, do their homework, and pass tests. The presence of other pupils in the class may make people struggling with multiplication tables feel embarrassed when asked to recite them.

It is, therefore, imperative that intensive instruction and effective intervention strategies be utilized in order to remediate the problem or help pupils with mathematics disabilities cope with the learning of quantitative reasoning skills specifically and mathematics generally. In recent times, the methods of teaching mathematics have become a source of concern to researchers, educators, parents, and education stakeholders. It is becoming increasingly clear that the traditional method of rote learning has failed to address the problems of pupils with mathematics disabilities. Students with mathematics disabilities lag significantly behind their peers without intensive instruction and intervention (Hott, Isbell, and Montani, 2014). Consequent upon this, several strategies have been evolved to help pupils with learning disabilities when learning certain aspects or concepts in mathematics.

Some of the strategies that have been used by teachers when teaching pupils with mathematics disability includes: find what you are solving for; ask yourself what the parts of the problem are; set up the number; display the sign; discover it; answer the problem; write and check the answer (FAST DRAW) strategy as proposed by Mercer and Miller (1992) to help pupils solve word problems in mathematics. This strategy was used to help pupils acquire problem solving skill in word problem. The strategy focused on teaching each step in the sequence allowing sufficient time for guided practice before asking pupils to independently implement the strategy. Other techniques like Mnemonic, key word approach, concrete – Representational – Abstract strategy etc have been used to teach aspects of mathematics such as word problem, fraction, multiplication, algebra, geometry and statistics respectively. But there seems to be no known strategy adopted specifically to teach or help pupils with mathematics disabilities acquire, this all-important quantitative reasoning skill that has recorded success. On this premise therefore, the researcher deemed it necessary to examine guided discovery and model-lead-test strategies in helping pupils acquire quantitative reasoning skills. The moderating effect of gender and mathematics anxiety also needs to be examined.

Guided discovery learning provides students with varying amounts and types of guidance to find (discover) information with only provided materials. Thus, guided discovery is a methodology that guides teachers to frame their lessons so that pupils can discover the answers to mathematical problems for themselves. Mosston and Aslawarth

(2012) contend that teachers should guide and facilitate pupils' learning within this particular strategy to encourage pupils to discover and participate in ongoing activities. Students can discover solutions to their problems using guided discovery. This allows them to develop the skills and abilities necessary for enquiring, comparing, imagining, discovering, evaluating, and drawing valid conclusions regarding various aspects of mathematics.

This strategy seems arguably useful in teaching quantitative reasoning to pupils with mathematics disability, considering the sharp contrast between guided discovery and other methods previously used as Mosston (2016) noted aptly that previous methodologies do not engage students within operations and classroom functioning. Within the conventional teaching strategies, students are not required to deduce answers for themselves but to simply take what the teacher presents to them without necessarily knowing the procedure or underlying principles that are applied. Guided discovery strategy is not only pupils friendly it is also pupils centered. The guided discovery strategy's focus is to develop logical and sequential thinking in the pupils. In this method, learners are led to discover a new concept, principle, relationship, or rule through logical and sequential questions (Spectrum of teaching styles, 2012).

Like any other vocational skill acquisition, authentic learning is learning by doing. Learners are engaged in learning when they are allowed to discover. The joy of discovery motivates students to learn (Jawaharlal, 2017). Guided discovery is helpful at all levels, especially when fundamental concepts are involved. It may be effective for all categories of learners. Jawaharlal (2017), however, recommended that guided discovery strategies be completed on time. Learning principles, concepts, rules, and relationships in this way takes time, but it will undoubtedly improve learners' understanding of them. Guided discovery is most effective when the task is less black and white (Chalk and talk) and when successful performance depends on making judgments in multiple situations. However, the result would be much more profound and enjoyable learning if it is well managed.

Model-lead-test is another instructional strategy that can be helpful to pupils who have mathematics disabilities. It could be particularly useful for teaching quantitative reasoning skill in primary school. Model-lead-test strategy could be an excellent strategy for teaching quantitative reasoning especially with pupils with mathematics disabilities. This strategy involves three very important steps or stages. (1) The teacher models, solving the problem while the pupils think through the modeling. (2) The teacher leads the pupils through solving the problem. (3) The teacher then tests the pupils to apply the strategy in solving problems independently. It simply gives the pupils the opportunity to be shown the "model answer" and to practice solving the problems.

It is not just about the teacher leading the test and the pupils watching. The teacher does it while involving the pupils in all aspects of the process, including thinking and doing. By modelling, the teacher does less, and the students do more. For the first example, Karen (2013) noted that the teacher does most of the work. In the second example, the teacher performs a lesser amount of work, and so on, until the fourth or fifth example, where pupils are responsible for most of the work. The teacher will model various quantitative reasoning problems with the students as a simple example. Pupils are taught by following the teacher's example. After giving each pupil the same problem, the teacher will guide them through it. Students can practice correctly solving the problem here with the teacher's help. Students are given their problems to solve after the teacher models the problem and leads them through it. When the pupils are tested, this will enable the teacher to see whether the pupils have a grasp of quantitative reasoning through the model-lead-test strategy and to determine which gender benefits more from the strategy.

Gender factor is very strong in learning as most classrooms are made up of both male and female pupils and this determines interest, achievement and consequently career choice of school leavers (Odual, 2013). Badmus (2006) argued that boys are more capable of learning mathematics than girls. Similarly, in their studies, Ojo (2004) and Omobanjo (2008) found that boys excelled in mathematics significantly more than girls. The differences in performance of boys and girls have been attributed to factors like genetics, societal influence and expectations and mathematics anxiety levels (Badmus, 2006). It seems that, sometimes the difference is overstated thereby causing debate among scholars whereas this study considers it necessary to examine the impact of gender on quantitative reasoning skills of learners with mathematics disabilities.

Gender parity and gender equality are unifying threads throughout the education system (UNESCO, 2012). Girls and boys should be equally involved in education, according to UNESCO (2012). A study by Boaler (1997, 2002) found that pupils' levels of mathematics anxiety affect their attitudes and performance differently. There is great fear, anxiety, and avoidance among students regarding mathematics. Hence as anxiety increases, confidence decline drastically. A negative attitude towards mathematics can impede a pupil's success in quantitative reasoning and consequently result in poor performance, even though proficiency in quantitative reasoning is essential for high performance in mathematics.

Mathematics anxiety is one of such attitude that can negatively impact on pupils quantitative reasoning skills. Shore (2013) asserted that many pupils' blood pressure spikes at merely mentioning the "m" word. When they encounter mathematics information, their brains shut down, resulting in fear and anxiety replacing clear thinking and the need not to look stupid in front of their peers. Mathematics anxiety is an emotional discomfort that makes a person uneasy when confronted with numerical information. A wide range of everyday life and academic situations can be hampered by mathematics anxiety (Harari, Vukovic, and Bailey, 2013, p.538). Math anxiety inhibits cognitive abilities and negatively influences mathematics perception (Geist, 2010; Wu, Barth, Amin, Mclaren and Menon, 2012). We feel helpless, shameful, and mentally incoherent whenever we face mathematical challenges.

Children can develop mathematics anxiety, but its onset age is unknown. Some researchers believe that mathematics anxiety is caused by children encountering complex mathematics curricula, having time to internalize negative feedback, and occurs mainly in upper primary school (Zakaria and Nordin, 2008; Wu et al., 2012; Harari et al., 2013 and Lerner and Friesema, 2013). In a recent study, Price (2015) concluded that children in the fourth, fifth, and sixth grades are within the accepted threshold of mathematics anxiety. As a result of mathematics anxiety, pupils are less likely to perform well in quantitative reasoning and mathematics, especially since pupils with mathematics anxiety generally do not enjoy mathematics. Consequently, they are less likely to participate in mathematics activities and classes since they perceive their mathematics abilities to be lower. Mathematics anxiety leads students to avoid mathematics classes or take high-level mathematics courses.

Mathematics anxiety therefore seems to account for the persistent poor performance of pupils in quantitative reasoning. Unless mathematics anxiety is confronted and remedied it may cause pupils to alter their educational pursuit and career ambition. When educational pursuit or career ambition is altered it may slow down academic progress or ultimately cause the pupils to abandon their educational aspiration at secondary and higher education. Literature has shown that performance in mathematics has been poor among primary school pupils and more so with pupils with learning disability in mathematics. Studies have shown clear disparity between what pupils with learning disability are capable of achieving and their actual achievement. This achievement gap seems to be widening by the day. It is imperative therefore that this ever-widening gap be bridged, not only in the interest of the pupils but also in the interest of the education system. On this premise therefore, this present study deems it necessary to examine the effect of two teaching strategies – Guided-discovery and Model-lead-test on the quantitative reasoning skills of primary school pupils with mathematics disabilities in Uyo, Akwa Ibom State.

1.2 Statement of the Problem

Mathematics seems to be a dreaded subject among school population. Learners hardly see any connection of mathematics to real life. They find it difficult to see the need of studying the subject as it seems to have no direct bearing with their life. This notion about mathematics has persisted over time and may not be unconnected with the lack of quantitative reasoning skills among learners at all levels of education. This has led to persistent poor performance in mathematics in primary school and beyond. Poor performance in mathematics in primary and secondary schools is becoming increasingly worrisome to teachers, parents and the general public. Mathematic is a compulsory school subject and pupils cannot do without in secondary school if they must proceed to higher institutions, if they do not have a credit pass in mathematics as it is a compulsory requirement to gaining admission into any course of study in the higher institution.

Pupils with mathematics disability seem to be already disadvantaged and may drop out of school if nothing is urgently done to equip them with the requisite quantitative reasoning skills. To do well in mathematics, pupils need to be equipped with adequate quantitative reasoning skill. Pupils have persistently shown poor level of performance in mathematics generally and quantitative reasoning specifically. It is unfortunate that the conventional teaching methods used in general education classrooms to teach mathematics and by extension quantitative reasoning have not been able to meet the needs of pupils with mathematics disability. The teaching and learning of quantitative reasoning skills have persistently posed serious challenges to both teachers and pupils with mathematics disabilities, as teachers themselves seem to lack requisite pedagogical competence for presenting quantitative reasoning instruction to pupils with mathematics disability.

The obvious effect of this has been the continuous poor performance of pupils in the subject area – mathematics. Mathematics difficulty as it were, does not only retard pupils' progression from one level of education to another but also impede their future career and life ambition. Primary school pupils with mathematics disability have long suffered setbacks within the regular education classroom as conventional instructional strategies seem not to meet their challenges in learning quantitative reasoning skills. As a result of their difficulties in coping with abstract nature of the subject and the complication that arise from the unfriendly methods of teaching, pupils with mathematics disabilities have been continuously sidelined in classes and made to believe that mathematics is not a subject for the likes of them

Pupils with mathematics disabilities fall substantially behind their peers without intensive, appropriate educational support and instruction. Pupils with mathematics disabilities keep struggling with quantitative reasoning skills in general education classrooms. This has impacted negatively on their ability to solve problems on quantitative reasoning leading ultimately to persistent failure in mathematics in examinations. It has raised concerns among educators as well as researchers; some have attributed that predicament to a number of factors such as inadequate motivation, inadequate provision of materials, teachers' lack of requisite teaching skills and qualification. Consequent upon this, research endeavours over the years have tried to provide remediation to this problem. In spite of the effort made by previous researchers the problem still persist and seems to be on the increase among school pupils. It is on this premise that this researcher deemed it necessary to examine the effect of guided discovery and model-lead-test strategies on quantitative reasoning skills of pupils with learning disabilities in mathematics in Uyo, Akwa Ibom State.

1.3 Objective of the study

The purpose of this study was to examine the effect of guided discovery and model-lead-test strategies on quantitative reasoning skills of pupils with Mathematics disability. Specifically, the study examined the effect of:

1. treatments – guided discovery and model lead test on quantitative reasoning skills of pupils with mathematics disability
2. gender on quantitative reasoning skills of pupils with mathematics disability.
3. mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.
4. treatments and gender on quantitative reasoning skills of pupils with mathematics disability.
5. treatments and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability
6. interaction effect of gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics
7. interaction effect of treatment, gender and mathematics anxiety on quantitative reasoning of pupils with mathematics disability.

1.4 Hypotheses

The following null hypotheses were tested at 0.05, level of significance.

There is no significant main effect of

1. treatments – guided discovery and model lead test strategies on quantitative reasoning skills of pupils with mathematics disability
2. gender on quantitative reasoning skills of pupils with mathematics disability.

3. mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

There is no significant interaction effect of:

4. treatments and gender on quantitative reasoning skills of pupils with mathematics disability.
5. treatments and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability
6. gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability
7. treatment, gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

1.5 Significance of the Study

This study would be of immense benefit to pupils with mathematics disabilities, teachers, parents, school administrators, curriculum planners and the educational system in general. Pupils with mathematics disability would benefit from this study in the sense that this study would help them to improve upon their quantitative reasoning skills consequent upon such improvement their performance in mathematics will be greatly enhanced. It would help them to overcome their mathematics difficulties to a large extent. The good news therefore is that poor performance in mathematics would become a thing of the past for them. Teachers of pupils with learning disabilities would find this study very useful. The findings of this study would equip the teachers with new teaching skill, techniques and strategies that can make the teaching of mathematics generally and quantitative reasoning specifically very interesting to the pupils.

Teacher would find the teaching of mathematics simple and enjoyable as against their previous experience of difficulty and confusion about teaching the subject to pupils with mathematics disabilities. The findings of the study would actually demystify the teaching and learning of quantitative reasoning skills and mathematics. This is important because many primary school teachers like the pupils, dread mathematics. As teachers learn new strategies for teaching quantitative reasoning, pupils would be looking forward to attending mathematics classes regularly instead of avoiding classes. Parents who have children and wards with mathematics disability will become happier seeing their children performed better in mathematics. As pupils improve in their quantitative reasoning skills, the parents would be more willing to support the pupils more with financial and material resources that are required to see the pupils through school. Parent would develop more confidence in the school and the teachers. This study would also provide parents with the knowledge and skills for making learning in and outside the school more productive. This study would strengthen parent-teachers relationship that will enhance school-home collaboration it the interest of the pupils.

School administrators would also find this study to be beneficial. It will provide the school with relevant knowledge and strategy that make pupils' success in school laudable. The results of this study will be of great interest to school administrators as they will realize what aspect of the subject to focus more on and what to expect as an outcome. It will help the school administrators to know what areas to channel their human and materials resources to in order to produce maximum result. The findings of this study would provide curriculum planners with knowledge of relevant curriculum areas. It would help them realise the important aspect of mathematics to emphasis while planning the school curriculum. Educational system generally will get a boost with the in-depth findings of this study.

1.6 Scope of the study

The study covered guided discovery and model-lead-test strategies on quantitative reasoning skills of pupils with mathematics disabilities. Two moderators are apt to this study – gender and mathematics anxiety. The study also covered Uyo senatorial district of Akwa Ibom State which comprised nine (9) Local Government Areas, namely Uyo, Etinan, Nsit Ibom, Uruan, Nsit Ubium, Itu, Ibiono Ibom, Nsit Atai and Ibesikpo Asutan.

1.7 Operational definition of terms

The following terms were defined operationally as used in this study.

Guided discovery: This is an instructional strategy whereby the teacher guides the pupils step by step to discover facts, concepts and answers to mathematical problems.

Model-lead-test: This is a teaching strategy where the teacher provides, a model, leads the pupils to apply the problem-solving skill and test the pupils to solve the problem independently.

Learning disability: a specific or non-specific spectrum of disorders that inhibits an individual's ability to learn through conventional teaching methods

Pupils with mathematics disabilities: These are pupils that have significant difficulty learning basic number facts and to do mathematical calculation.

Mathematics disability: Pupils inability to carryout basic mathematical operations that pupils of that age can do easily.

Quantitative reasoning skill: Pupils ability to use simple numerical skills to solve practical real-life problem.

CHAPTER TWO

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

In this chapter literature were reviewed extensively on the following subheading: conceptual review, theoretical review and empirical review

2.1 Conceptual review

2.1.1 Concept of learning disabilities

Learning disabilities (LD) cover a wide range of learning problems. An impairment of learning skills is known as a specific learning disability. Children and adults can suffer from learning disabilities. Often, the impairment goes undetected throughout life due to its subtle nature. Individuals with these disabilities are not able to perform at their best every day due to these disabilities. Learning disabilities interfere with every aspect of life, including cricket, football, getting dressed, and keeping the room clean (Bhandari and Goyal, 2014).

Learning disabilities can make it difficult for individuals to learn and use specific skills. In addition to reading, writing, listening, speaking, reasoning, and doing mathematical calculations, the most affected skills include reading, writing, listening, speaking, and reasoning (National Association of Special Education Teachers, 2007). There are different types of learning disabilities. For example, someone with learning disabilities may have difficulty reading and writing. It is also possible for someone with learning disabilities to have difficulty learning and understanding mathematics. Social skills may be challenging for another person (National Dissemination Center for Children and Youth with Disabilities (NDCY, 2004).

Some conditions that fall under this category are disability-related perception, mild cognitive impairment, dyslexia, and developmental aphasia. Problems with learning caused by visual, hearing or motor impairments, mental retardation, psychological disturbances, or economic, social, or cultural limitations do not qualify (Great, 2010). According to Ali and Refi (2016), learning disabilities result from differences in brain wiring. There is no difference in ability or intelligence between children with learning disabilities and their peers. Nevertheless, if they are not taught correctly, they may have difficulty reading, writing, spelling, reasoning, and organizing information. There is no cure or cure-all for learning disabilities.

The condition is lifelong. Whatever the case, children with learning disabilities can succeed in school and become successful in their chosen careers if provided with the appropriate support and intervention. Using strengths, understanding weaknesses, working with professionals, and learning strategies to cope with learning disabilities, Wiig and Semel (2014) suggest that parents can support their children to succeed in school. It is possible to have learning disabilities and other disabilities at the same time. When a student's primary problem is a learning disability, a specific learning disability can be identified. Identifying other disabilities, such as intellectual disabilities, severe emotional disturbances, sensory impairments, motor disabilities, or autism spectrum disorders, and determining which disability dominates must occur immediately (Ali and Rafi, 2016). It is common for students with learning disabilities to encounter academic difficulties in the same way as low achievers (Fletcher, Lyon, Fuchs and Barnes, 2017).

Despite this, one of the most critical factors for identifying a learning disability is whether the student has not made progress in one or more academic areas after receiving appropriate instruction. Reading comprehension or reading fluency are among the basic reading skills. Some students possess exceptional abilities despite being evaluated for a specific learning disability, as Reis and Colbert (2014) pointed out. A student with a learning disability might be academically gifted or intellectually gifted. The "twice exceptional" group includes diverse students with advanced academic abilities. Although they have specific learning disabilities, they often require remedial intervention in other areas (Ali and Rafi, 2016). Some pupils with reading disabilities have verbal 1or mathematical skills, while others with mathematics disabilities have strong language or reading skills.

Accordingly, specific learning disabilities can affect people of all intellectual levels (Reis, Neu and McGuire, 2015). Learning disability was described by Oban (2006) as a hidden disability that is not readily apparent. Since learning disabilities are hidden and complex, it is difficult for parents, teachers and non-professionals to comprehend their dilemma. Thus, children with learning disabilities are incorrectly viewed as uncooperative, lazy, and unproductive (Bergert, 2000).

2.1.2 Characteristics of learning disabilities

Several related signs are often present in children with learning disabilities, and they persist over time. Learning disabilities manifest differently in different people (National Institute of Neurological Disorders and Stroke, 2012). It is common for pupils with learning disabilities to find it challenging to read, write, and do mathematics. Moreover, they need to pay attention, follow directions, have better coordination, and have difficulty understanding time concepts and staying organized (NINDS, 2012).

America Academy of Child and Adolescent Psychiatry [AACAP, (2011)] stated, in addition to the above, that pupils with learning disabilities may also demonstrate the following characteristics: The failure to respond appropriately in school or social situations, the difficulty staying focused on the task at hand (that is easily distracted), inability to find the right words to say something, inconsistent school performance, immature speech, difficulty listening effectively, difficulty understanding words or concepts when faced with a new situation. Many students with learning disabilities can be found in a regular classroom. The government of Nigeria has introduced free and compulsory primary education over the last decade, which has increased to pupils attending traditional schools. Thus, Filippatau Kaldi (2010) and Elliot (2000) stated that mainstream schoolchildren face various learning challenges; as Lerner (2004) pointed out, pupils with a learning disability experience a variety of cognitive and psycho-emotional difficulties.

Students with language-based challenges are about 80%. They have difficulties with working memory, paying attention or concentrating, and applying learning to new contexts. They cannot organize knowledge or solve problems using cognitive and psychological strategies (Sideridis and Scanlon, 2012). Parents, educators, and others have identified the characteristics of learning disabilities over the years (Gargiulo, 2014). Identifying the characteristics of learning disabilities was first accomplished by Clement (1966). In addition to hyperactivity, impulsivity, and memory disorders, the following are also present: emotional lability, academic difficulties, coordination difficulties, language deficits, and problems with attention (NASET, 2017).

Learning disabilities are also associated with nine learning and behavioural characteristics (Lerner, 2000). They include attention disorders, reading difficulties, motor difficulties, difficulty writing, difficulty speaking, deficits in social skills, psychological problems, cognitive disorders, and information processing problems (NASET, 2017). Batshaw and Perret (2014) pointed out that children with learning disabilities exhibit various characteristics. It is common for children with learning disabilities to exhibit the following characteristics: Specific academic skills deficits: The following academic areas may be difficult for students with learning disabilities: Reading comprehension, writing, written expression, spelling, mathematical computations, mathematical reasoning, acquiring basic reading skills, including learning letter names and sounds, blending, and analyzing phonetics and structures.

Major characteristics of individuals with learning disabilities include but not limited to:

Perceptual motor impairments: Children with learning disabilities may have difficulties differentiating objects by shape, size and colour. Their fine motor skills may be affected by problems with writing, colouring, and cutting. Reversals of letters or numbers may also occur.

Memory and thinking disorders: Children with learning disabilities may experience problems with short-term memory and cannot solve problems and perform tasks effectively. They are incapable of memorizing and recalling information. It is, therefore, easy for them to forget even the most recent information they have heard.

Attention disorder: As a result of learning disabilities children may have difficulty concentrating or remaining on task long enough to complete it. They are frequently jump from one activity to another. They are easily distracted as a result they can hardly finish what they started.

Hyperactivity: It is difficult for such children to sit still. They are constantly moving (in motion). Inconsistently engaged in academically relevant activities while doing irrelevant things.

Impulsiveness: Such children normally act without thinking or act before they pulse to think, have poor planning and organizational skill. They respond to question quickly without thinking and so make many errors. They lack self-regulation skill.

Emotional deficits: Their peers often reject them and are always in a foul mood. In addition to having a low sense of self-esteem, they are likely to violate social norms. Batshaw and Perret (2014) assert that they are passive learners rather than active ones.

2.1.3 Causes of learning disabilities

There are no physical signs of disability in children with learning disabilities. There is no known cause of learning disabilities (Batshaw and Perret, 2014; NASET, 2017). It is assumed, however, that the pupils with learning disabilities are as diverse as the condition's symptoms. Learning disabilities may be caused by differences in brain structure, although researchers are not entirely sure (National Centre for Learning Disabilities, 2012). There are four possible causes of learning disabilities: brain damage or dysfunction, heredity, biochemical imbalances, and environmental factors (Heward, 2010). Brain damage or dysfunction: Experts in learning disabilities believe that people with learning disabilities suffer from neurological disorders. NJCLD (2004) stated that the disorders result from "central nervous system dysfunction".

The condition has been linked to minimal brain dysfunction, with no evidence of brain injury or damage. Medical practitioners mainly use this. However, Richards (2001) and Shaywitz et al. (2004) warned that special educators must beware of emphasising theories that link learning disabilities to brain damage or brain dysfunction. The exception was based on four simple reasons:

1. There is no clinical evidence that all children with learning disabilities have brain damage; the same is not true of all children with brain damage.
2. When a child's learning problems are assumed to be caused by brain damage, educators can quickly build on such excuses as reasons for ineffective instruction. Teachers will claim that the child can never learn with brain injury or damage.
3. Whether learning disabilities in an individual are caused by developmental delay or brain injury, the teaching method does not essentially change (Fletcher et al., 2017).

Heredity factor

Genes determine learning disabilities, which can be passed down from parents to children. According to Pennington (1991), reading disorders may be caused by genes on chromosomes 15 and 6. There is a greater likelihood that children and siblings of people with reading disabilities will have reading difficulties. Alcohol or drug use during pregnancy can sometimes cause a learning disability in a developing fetus. Twin studies, sibling analyses, and family pedigree analyses have been used to study the genetic basis of learning disabilities (Raskind, 2011). It has been reported that for identical twins with reading disabilities, the probability of the other twin having the same disability is 68%; for fraternal twins, the probability is 40% (NASET, 2017).

Biochemical imbalance

Electrical impulses between neurons are controlled and released by chemicals in the brain. Learning disabilities can result from abnormal electrical activity in the brain caused by the absence or excessive presence of biochemical substances. It has been suggested by Heward (2017) that biochemical disturbances within their bodies may cause children's learning disabilities. Despite this, Heward noted that most learning disability professionals do not consider biochemical imbalances a significant cause of learning disabilities in children.

Environmental factors

There is a possibility that a child may suffer from learning disabilities as a result of poor living conditions and poor instruction at an early age. Hart and Risley (2015) opined that infants and toddlers who are not frequently communicated with by their parents might have deficits in vocabulary, language use, and cognitive development. Quality of instruction is another environmental factor that may cause learning disabilities. Poor instruction only partially accounts for most children's learning difficulties. However, Heward (2016) believes that many students can overcome their learning difficulties through intensive, direct, and systematic instruction, which would otherwise result in persistent problems. Environmental factors can directly contribute to learning disabilities. Researchers have found that malnutrition, premature birth, inadequate prenatal and postnatal care, stress, poor parenting, and poor instruction harm learning (Kronenberger and Meyer, 2001; Silver and Hagin, 2002; Rozario, 2003; Bhandari and Goyal, 2014). In these circumstances, brain dysfunction is more likely to occur.

2.1.4 Types of learning disabilities

Learning disabilities are often grouped according to academics skills that are affected. The type of learning disabilities that are conspicuous among school children revolve around reading, writing or mathematics. Here are the specific learning disabilities common among school children – dyslexia (reacting difficulty), dyscalculia (mathematics difficulty), dysgraphia (writing difficulty) and dyspraxia (motor skills difficulty).

Reading disability (Dyslexia)

Reading disorders such as dyslexia occur when students cannot recognize and comprehend written words. This impairment affects reading ability despite average intelligence, regular reading opportunities, adequate instruction, and a supportive home environment (NASET, 2017). Learning disabilities include dyslexia. Having trouble decoding single words is a characteristic of this disorder. There are two types of learning disabilities in reading, according to Kemp, Smith, and Segal (2017).

1. It is difficult to understand the relationship between sounds, letters and words when there is a fundamental reading problem. Another problem is reading comprehension, where the reader needs help understanding words, phrases, and paragraphs. There are several types of dyslexia, according to the American Academy of Special Education Professionals (2007)

a. Those who have direct dyslexia can read words aloud correctly but cannot comprehend what they have just read.
b. a person with dyslexia will use word attach skills (phonetics) to learn sight words.
c. Dyseidetic dyslexia

Children with dyslexia have difficulty learning literacy and numeracy (UNESCO, 2009). Short-term and long-term memory, speed processing, sequencing abilities, auditory and visual perception, spoken language, and motor skills are all persistently weak in children with autism.

Mathematics disability (Dyscalculia)

Learning disabilities such as dyscalculia affect an individual's ability to use and understand numbers properly. Arme (2016) referred to dyscalculia as “number blindness” or “numerical blindness” According to Arme it literally means “bad counting”. For pupils who truly have dyscalculia, trouble with mathematics is not a matter of how it is taught. It is actually a lack of number sense. This problem stems majorly from two areas of weakness (1) visual spatial difficulty (2) language processing difficulty. A child with visual spatial difficulty has a problem processing what the eye sees. As a result he has difficulty visualizing pattern of or parts of mathematics problem (Arme, 2016). With a language processing difficulty, the child has problem making sense of what the ear hears. This may lead to difficulty grasping mathematics vocabulary and building on mathematics knowledge since he has problem understanding what the words represent.

There is a lack of knowledge about the prevalence, causes, and treatment of dyscalculia, according to UNESCO (2009). Number concepts are complex for children with dyscalculia, numbers are intuitively challenging to comprehend, and number facts and procedures are difficult to learn. Newman (2017) observed that students with mathematics learning disabilities have difficulties orienting themselves in directions. Because of all the computational directions involved in operations such as long division, multiplication, fractions, and equations, they become highly disoriented.

Learning disabilities in mathematics are called dyscalculia. Mathematics is difficult for students with dyscalculia on a variety of levels. It is common for them to have difficulty understanding concepts such as more significant than versus smaller than. In addition to fundamental mathematics problems, they may need help with more abstract mathematics problems. Mathematics and tasks involving mathematics are complicated for those with dyscalculia. Mathematics dyslexia, mathematics learning disability, and mathematics dyslexia are some terms used in the field. Despite their similarity, dyslexia and dyscalculia can be misleading. Dyslexia is a reading disorder, whereas dyscalculia is a math disorder. There is no cure for dyscalculia, as it is a lifelong disability. Mathematics can be a challenge for children as well as adults. They can, however, improve their mathematics skills by employing some strategies. Mathematics is difficult for all levels of learners. As difficult as learning algebra can be, learning addition can be equally tricky. It can also be difficult to understand basic concepts like quantities. They are all based on number sense, an essential mathematical skill.

A study by Geary (2011) found that poor mathematical skills are prevalent among adults, making it difficult to find a job and perform their daily routines. Mathematical learning disabilities affect approximately 7% of students, and 10% continue to have low achievement in mathematics despite average capabilities in most other areas. Like their low-achieving peers, children with mathematics learning disabilities struggle to understand and represent numerical magnitude. They find it challenging to recall basic arithmetic facts and experience delays in learning mathematical procedures. Unlike low achievers, children with mathematics learning disabilities suffer from deficits in working memory, not intelligence. Interventions are being developed to address these underlying cognitive deficiencies, and preliminary results are encouraging (Geary, 2010).

Mathematical learning disabilities and learning difficulties associated with persistently low math achievement are not due to intelligence, according to Geary (2011). Mathematics learning is associated with more significant memory delays and deficits for these individuals. In addition to addressing these deficits, the most promising interventions target the low working memory capacity of children with mathematics learning disabilities.

Signs and Symptoms of Dyscalculia

People with dyscalculia encounter mathematics difficulties in various ways. The signs of dyscalculia differ from person to person and age. Some children can have difficulty understanding numbers as early as preschool. In other children, difficulties become evident as mathematics reaches a higher level of complexity. There are several signs and symptoms of dyscalculia, including:

- Identifying the significance of quantity or concept such as biggest and smallest, more significant than and less than
- Recognizing the similarities between the numeral five and the word five
- Remembering mathematics facts in school, like times tables
- Counting money or making change
- Estimating time

- Judging speed or distance
- Understanding the logic behind mathematics word problem
- Solving problems by holding numbers in their heads

Possible causes of dyscalculia

The exact cause of dyscalculia is unknown. The difference may be caused, at least in part, by differences in the structure and function of the brain. Two different factors can cause dyscalculia:

1. **Genes and heredity:** Dyscalculia is a genetic disorder. Mathematical problems may also be influenced by genetics.
2. **Brain development:** Brain imaging studies revealed some differences between individuals with and without dyscalculia. Learning skills are connected to how the brain is structured and functions.

There is more to dyscalculia research than just finding out what causes it. A second goal is to find out if there are strategies that can make mathematics more accessible by "rewiring" the brain.

Writing disability (Dysgraphia)

Dysgraphia is characterized by difficulty expressing thoughts graphically and in writing (UNESCO, 2009). Abysmal handwriting generally falls under this category. The Learning Disabilities Association of America (2012) reported that children who suffer from this disorder might contort their bodies when holding a pen or pencil. An individual who cannot outgrow abysmal handwriting may have dysgraphia. Children with dysgraphia may exhibit the following signs, according to the National Centre for Learning Disability (2016). Generally clumsy in writing, trouble writing down ideas, a fast loss of interest while writing, difficulty sequencing thoughts, difficulty learning unfinished or omitted words.

2.1.5 Identification of pupils with learning disabilities

It is important to identify pupils with learning disabilities for the purpose s providing necessary remediation or intervention. If pupils are not properly identified, they remain at risk of for poor or negative outcome in both childhood and adulthood. Basically, learning disabilities have been identified through intelligence quotient (IQ) test in conjunction with achievement test. According to Gotfredson and Deary (2014), using IQ tests to predict which child would succeed in school is not surprising. IDEA (2004) stipulated that, for a student to qualify as having learning disabilities, he/she must show a severe discrepancy between intellectual ability and academic (actual) performance. Following the stipulation of IDEA (2004), such differences must be apparent in communication skills, speech comprehension, written communication, reading comprehension, comprehension of text, Mathematics calculation, and reasoning.

Recently, this severe discrepancy in criteria for identification has come under severe criticism. IQ-achievement discrepancy means the child has to fail for an extended period to meet a severe discrepancy requirement. Fuchs, Fuch and Stecker (2010) and Kavale (2015) argue that this is not good for the child or the school to use this identification method. Lyon (2017) affirmed that younger individuals with any learning disability go unidentified and untreated. The more complex the remediation task becomes, the more difficult the response will be for the children. The lack of early identification of pupils with learning disabilities has been attributed to some factors inherent in learning disabilities. As Fletcher, Francis, and Rourke (2013) noted, a lack of a theoretically based classification system and a precise definition exacerbated the problem. (1) identifying types of learning disabilities and (2) distinguishing between learning disabilities and other learning disorders, such as intellectual disability, attention deficit disorders, difficulties with speech, and poor performance in academics.

The Connecticut state Department of Education (CSDE, 2014) had proposed alternative procedure for identification. It stated that, for a child with learning disabilities to be so identified the following question must be satisfactorily answer:

1. Is general education well acquainted with the curriculum and actively engaged in learning?
2. What strategies and interventions have been used to instruct and support the pupil?
3. Is there data suggesting that the pupil has received appropriate instruction, including mathematics and reading intervention?
4. Might the pupils' learning problem be primarily due to a visual, hearing or motor impairment or other disabilities?

5. Is the socio-cultural background of the pupils considered? Did the teacher provide culturally relevant instruction to the student?

2.1.6 Prevalence of learning disabilities

The prevalence of learning disabilities among school pupils varies considerably depending on the criteria used, but it has been estimated by several researcher (e g Pennington, 1991; United State Department of Education, 1999, Sharma, 2003; Tollefson, Tracy, Johnson and Chapman, 2006) that the range of prevalence has been 5-10 percent of school population. A survey conducted by Suresh and Sebastian (2013) showed that a prevalence rate of 7-8 percent of the general population having specific learning disability. Sadock and Sadock (2013) found that 2-8 percent of school population have a learning disability. According to them, there are three to four males for every female with reading disability.

Studies (Spafford and Grosser, 2006; Kronenberger and Meyer, 2011; Sadock and Sadock, 2013) have shown that dyslexia (an inability to read) is the most common form of learning disability among primary school pupils. According to the survey report of Sadock and Sadock (2013), one percent (1%) of school-age children have a mathematics disability (dyscalculia), which represents one in every five pupils with learning disabilities. About four percent (4%) were found to have a writing disability (dysgraphia). It is difficult to determine the prevalence rate of specific learning disabilities among school-age pupils since several studies tend to lump several disabilities together instead of separating them into a single group (Bhandari and Goyal, 2014). Because there is no standard definition of learning disabilities and objective diagnostic criteria, there is much disagreement about the prevalence of learning disabilities.

Researchers (Lyon, 2006; Fleishner, 2014) have criticized the current 5% prevalence rate as vague and inaccurate. Researchers (kemp, Smith and Segal, 2017) estimate that 8% and 15% of school students suffer from learning disabilities in written expression. Torgeson (2012) also reports that approximately 6% of students have difficulties with the mathematics that are not related to high intelligence, sensory deficiencies, or economic disadvantage.

2.2 Concept of mathematics disability

Mathematics disability impairs the ability of students to comprehend basic mathematical concepts. People with learning disabilities have difficulty understanding how numbers relate to quantities. People with mathematics learning disabilities have difficulty understanding mathematical concepts and applying them to real-world situations like telling time, buying, and selling (Logsdon, 2017). Dyscalculia is a learning disability in mathematics that causes difficulty with basic mathematics skills. A basic understanding of mathematics and basic operations is needed. It affects the ability to understand mathematics process that applies in solving problems.

Dyscalculia is a mathematics disability. It is similar to dyslexia in the sense that the individual has problems with retention and confusion with mathematical symbols. Dyscalculia makes it difficult for the individual to count from 1 to 100 or even counting in threes. According to Jacobson (2017) dyscalculia does not end with school work, but the problem goes beyond school. Dyscalculia impacts on day-to-day activities such as making correct change of money, reading clocks accurately and so on. Where learning disability is not identified and remediated, it makes the child feels frustrated and embarrassed with handling computational mathematics problem all the time.

Garnett (2016) identified five types of mathematics learning problems that require different classroom approaches, modifications, and even divergent approaches. They are (1) mastering the basic facts of mathematics, (2) weakness in arithmetic/talent in mathematics, (3) the ability to write symbols and concrete materials, (4) the ability to write symbols and concrete materials, (5) the ability to write symbols and concrete materials. Despite adequate understanding and great effort, the primary number of facts in all four operations are challenging to memorize for students with learning disabilities. Instead of quickly learning that 5+7 = 12, 4x6 = 24, the students seem incapable of independently developing efficient memory or retention strategies (Garnett, 2016).

In examining the causes of learning disabilities in mathematics, Logsdon (2017) stated that learning disabilities applied to basic mathematics skills are likely to be caused by the impairment of the brain's language processing and visual reasoning skills centres. A hereditary component is also suspected (Jacobson, 2017). Learning disabilities in mathematics, according to Steinbach and Doughty (2012), do not necessarily stem from linguistic difficulties, learning difficulties or coordination issues. It is possible, however, for these conditions to complicate learning disabilities in mathematics.

2.2.1 Pupils with Mathematics disability

Approximately 5% to 10% of students experience severe mathematics disabilities before they graduate high school (Barbaresi, Katusic, Colligan, Weaver, and Jacobsen, 2005). The number of students who learn mathematics at the appropriate level will require a great deal of assistance (Fuchs, Fuchs, Mathes, and Lipsey, 2000; Murphy, Mazzocco, Hanich, and Early, 2007). Common difficulties in mathematics experienced by pupils with mathematics disabilities include the following as observed by Coleman and McQuillan (2010).

(a) Inability to recall basic facts automatically, such as addition facts or multiplication tables.

(b) A lack of understanding of algorithms (writing procedures) for multi-digit calculations, especially multiplication and division, but also a lack of fluency with these written calculations.

(c) Inability to understand math-related terms (e.g. equal, product, numerator, denominator) or the language of word problems (e.g., not understanding terms such as reduce or expand);

(d) Being unable to understand basic concepts like the base-ten system or fraction concepts: and

(e) Difficulty solving word problems.

With the current emphasis on credit passes in mathematics as a criterion for admission to tertiary institutions, pupils with learning disabilities need adequate preparation to meet these newly articulated mathematics expectations (Holt and Isbell, 2014). Special education teachers and general education teachers need a proper understanding of children with learning disabilities in mathematics, according to Gargiulo and Metcalf (2013) and Powell, Fuchs and Fuchs (2013), as well as strategies for helping them succeed in mathematics, including computational literacy and mathematics literacy, and access the general education curriculum.

There are six essential principles in mathematics education identified by experts (National Council of Teachers of Mathematics, 2000; Lyon, 2006; Fleishner, 2014): (a) equity - mathematics should be accessible to all students, irrespective of disability, background, or physical conditions; (b) curriculum - mathematics should not be viewed as a collection of isolated facts, but rather as a whole; (c) teaching mathematics is a combination of comprehensive knowledge of mathematics, an understanding of the development of individual pupils, and an understanding of how children learn mathematics; (d) learning - Mathematics must be taught in a way that promotes problem-solving, reasoning, and integrating new knowledge into existing knowledge; (e) assessment - Students are evaluated using a variety of techniques (e.g. math assessments embedded in real-world problems) This information is both valuable to teachers and students, and (f) technology - electronic technologies such In order to teach, learn, and practice mathematics, calculators and computers provide an opportunity for exploration and concept representation (NCTM, 2000).

Signs of mathematics disabilities

The signs of a mathematics disability include but not limited to the following Spending much time thinking about basic mathematical operations such as addition, subtraction, multiplication, and division (even when the question is straightforward).

1. A sequence of math operations cannot achieve the result.
2. The multiplication table can only be memorized or remembered for a few days.
3. Having memory problems leads to simple mistakes.
4. Mixing mathematical symbols.
5. Having difficulty understanding right-left concepts or making mistakes constantly.
6. Inability to concentrate on a task due to attention disorder.
7. Date, hour, and time concepts need to be understood.
8. Geometric shapes are not learned quickly.
9. Counting fingers for all math operations all the time.
10. A mistake in paying for something or needing help calculating the change while shopping.
11. Having difficulties counting coins.

12. Playing logical and strategic games incorrectly

Children may exhibit some or all of these symptoms. A specialist consultant may be needed for such a child. Several instructional strategies and exercises can be used to eliminate these deficiencies extensively if the child has no mental problems.

Causes of mathematics disability

1. At any stage of a child's academic development, mathematics disabilities can be caused by unknown and unknown factors. Although very little information is available regarding the neurological or environmental causes of these problems, many experts like Nathan, Lauren, Sarah and Nathan (2012) suggest a deficit in one or more of the five skill types. It is possible for these deficits to exist separately or to occur together. The presence of either of these factors, individually or in combination, can adversely affect a child's ability to succeed in mathematics. The following factors can contribute to mathematics difficulty.

1. **Incomplete Mastery of Number Facts**

Basic computations like 9 + 3 = 12 or 2 x 4 = 8 are normally referred to as number facts. All students are required to memorize number facts in the primary school. A student's ability to recall these facts efficiently enables the student to engage in advanced mathematical thinking efficiently.

2. Computational Weakness

Many children understand mathematical concepts but struggle with simple calculations in this condition. They tend to make errors when reading signs or to carry numbers because they must read them correctly. The numerals may need to be written clearly or in the correct position. Particularly in primary school, where the emphasis is on computation and "right answers," such children often struggle. Although they may be capable of higher levels of mathematical thinking, they may end up in remedial classes.

3 Difficulty Transferring Knowledge

Mathematics difficulties affect an individual's ability to relate mathematics' abstract or conceptual aspects to reality. To remember a concept well and quickly, a child needs to understand what symbols mean in the real world. Children find it much more meaningful to hold and inspect an equilateral triangle than to be told it is equilateral.

4 Making connections

Making meaningful connections within and across mathematical experiences can be challenging for some students. Students may need assistance understanding how numbers relate to the quantities they represent. Mathematical skills may only be anchored in a meaningful or relevant way if this connection is made—the difficulty of recalling and applying it in new circumstances increases.

5 Incomplete Understanding of the Language of Math

In some children, language problems lead to mathematics disabilities. Reading, writing, and speaking may also be difficult for these children. However, their language problems in math are further complicated by the inherently complex terminology, some of which they have never encountered outside the math classroom. It is difficult for these students to comprehend written or verbal instructions or explanations, and they need help translating word problems.

6 Perceptual Difficulties.

This is manifested in the inability to comprehend the visual and spatial aspects of mathematics. Most mathematics difficulties are caused by the inability to visualize mathematics concepts effectively. It may be necessary to help students with this problem judge the relative sizes of three objects. As a result of this disorder, students must memorize almost entirely verbal or written descriptions of mathematics concepts that most people take for granted. Students must also use higher-order cognition and perceptual skills when solving mathematical problems, for example, to determine a complex 3-D figure's shape when rotated.

Intervention for pupils with mathematics disability

The very essence of identification and diagnoses is for appropriate intervention to be initiated. To help pupils with mathematics disabilities, Arme (2011) suggested that parents, teacher and other educational specialist can provide intervention in the following ways:

1. Develop strategies for improving the mathematics skills of pupils based on evaluation results.

2. Extra tutoring includes adjusting the learning pace, focusing on specific areas of difficulty, and repeatedly reinforcing critical skills.
3. Using graphic organizers to organize ideas, concepts and skills for those with visual-spatial weaknesses.
4. It is vital to provide clear explanations and to check for understanding frequently when dealing with individuals who have difficulty processing language
5. A place that has limited or no distractions is always a good place to work with all of the necessary materials (pp. 23)

Newman (2017) added that a computer tutorial strategy provides the best chance of success by illustrating all concepts through multimedia animation with repetition of the information displayed with sounds, text, images and motion with a focus on concepts, symbols, vocabulary, syntax, and translation of the mathematical language. The importance of appropriate tools and technology when providing math intervention to children with disabilities cannot be overstated. According to Jacobson (2017), supportive tools and technology can assist students with learning disabilities in math. His view is that the child should be provided with a calculator, pencils, graph paper, phone reminders and alarms to keep track of time, and math computer applications and games to practice essential skills.

2.2.2 Concept of quantitative reasoning skills

Pupils' education depends heavily on their ability to think quantitatively. Online access to information is ubiquitous in this day and age. There is a great deal of quantitative information in this document. In making decisions in everyday life, pupils need to be able to analyse the information they receive as they sift through the data (Elrod, 2014). Primary school students who demonstrate a high level of quantitative reasoning tend to achieve somewhat higher scores on standardised achievement tests in mathematics and language (cognitive ability test - CogAT. 2014). Although the advantage persists through the secondary school years, it is confined to mathematics in the elementary years. According to Grawe (2012), quantitative reasoning involves analysing and interpreting real-world quantitative information, such as algebra, within a discipline context to draw meaningful conclusions. It is not just mathematics. Using quantitative evidence is a habit of mind for Rocconi, Amber, Alexander, and Shimon (2013) "for evaluating, constructing, and communicating arguments in public, professional, and personal life".

Quantitative reasoning achievement is one of the essential learning outcomes in primary, secondary and tertiary education. An intellectual competence consists of several practical skills, including inquiry, analysis, critical and creative thinking, written and oral communication, information, literacy, and teamwork. Achieving quantitative fluency is an essential intellectual skill all students and pupils must acquire (Sundre, 2017). There are five core competencies in the significant global educational review, rather than just literacy and numeracy: writing, oral communication, quantitative reasoning, critical thinking and information literacy (Steen, 2014). Quantitative reasoning helps pupils think critically and equip them with the ability to apply basic mathematic skills to interpret data, draw conclusions and solve real-world problems.

According to Elrod (2014), quantitative reasoning requires developing mathematical and statistical skills during primary school. It is a competency of integrating and applying intellectual capacities at the top of every cognitive skill. The following are indicators of relative quantitative reasoning strength:

- Students can think abstractly. A student with a lower ability level may be better at computational aspects than conceptual aspects of mathematics, which could indicate a quantitative strength.
- Based on their experience, students with high quantitative reasoning abilities typically recognize patterns and then reason based on them.
- Students often learn computer skills more quickly than their peers, including how to use word processors and spreadsheets. It is not uncommon for them to excel at computer programming unless they possess a high level of quantitative reasoning ability
- Students who learn rule-based mathematics often show better grammar skills than expected (CogAT, 2014, p. 18).

In the real world, examples of quantitative reasoning in everyday life abound virtually in any discipline. These principles can be applied in the fields of health, economics, politics, science, engineering, social science, and even the arts. When pupils in primary schools are asked what they want to become in future, they mention professions in most of these disciplines. At the core of those discipline is quantitative reasoning. Hence pupils who are proficient in quantitative reasoning achievement right from primary school may stand a better chance for successful public, professional and personal life in future. Hughes-Hallett (2011) argues that quantitative reasoning should be taught within the context of the discipline since a vital component of the learning outcome is the ability to identify quantitative relationships within different environments. In addition, quantitative reasoning involves problem-solving in real-world settings, which makes it intrinsically interdisciplinary.

Obviously, it not only school pupils that require the knowledge and application of quantitative reasoning, adults in all spheres of life do too. More so, the future of many professions remained blurred if the nation and all profession do not possess sufficient quantitative reasoning skills. Approximately 13 percent of adults are proficient in quantitative reasoning (National Assessment of Adult Literacy,2013). Miller (2010) argues that evaluating political polls requires quantitative reasoning skills to solve everyday problems like assessing the national debt, understanding nutrition facts, evaluating medical care, and investing. College students should focus more on quantitative reasoning to attain this literacy and overcome these challenges (Elrod, 2014). Education at all levels, from preschool to secondary school, is affected. AAC&U (2017) states that all curriculums should teach quantitative reasoning skills. However, mathematical content knowledge differs fundamentally from quantitative reasoning from a conceptual and practical standpoint. Expertise relies on this other form rather than being psychologically separate.

Assessment fairness and validity are closely related to being clear about the differences between quantitative reasoning and mathematical content knowledge. For quantitative reasoning assessments, it is essential to specify what mathematical content knowledge is required to solve the tasks represented in the assessment. Calculation load, visual and spatial components, speed of responding, and reading load are other potential threats to the validity of quantitative reasoning assessments. The concept of quantitative reasoning was used to assess published statements and mathematical content. Despite having the same target construct of quantitative reasoning, the content and format of most of the tests we reviewed differ. This may be due to differences in the program's purpose and the test population. An assessment's core concept needs to be linked to the actual test content and the reasoning it assesses through a construct-centred approach. Quantitative reasoning for assessment involves identifying and measuring specific steps in the solution of problems through the use of standardised tests. Quantitative reasoning problems require mathematical content knowledge (but more is needed) despite the difference between the two types of knowledge.

2.2.3 Why quantitative reasoning should be taught in primary schools

During the first few years of school, a solid foundation of mathematical understanding is laid. Primary school students should develop a positive attitude toward mathematics and acquire adequate mathematical skills. Therefore, primary teachers play a vital and influential role (Ministry of Education, 2013). In attempt to buttress the need for quantitative reasoning instruction in primary school especially for pupils with mathematics learning disabilities, Creswell (2016) list the following as basic concepts of quantitative reasoning that every school pupils need: An understanding of fractions, ratios, percentages, units, dimensions, exponents – laws of exponents, linear equations with one and two unknowns, factoring, quadratic formula, logarithms, relationship with exponents, problem-solving – formulae, solving, interpreting (Creswell, 2016).). To become an educated citizen, every pupil has to graduate from primary school capable of reasoning quantitatively.

In support of this, Davidson and Mckinney (2011) stated that it prepares students to be influential citizens in modern society. In Western Washington University's (2011) article on teaching quantitative reasoning skills to students, it was stated that mathematics is an essential skill for many students. The ability to reason, understand, interpret, debunk, challenge, explain and draw conclusions using simple mathematics tools. In general education classrooms, Trimble, Mckinney, Bulcroft, and Casto (2015) recommend establishing the following quantitative literacy or quantitative reasoning requirements:

- Formulas, graphs, tables, and schematics are used to interpret mathematical models.

- Use symbols, visuals, numbers, and verbal representations of mathematics. Solve problems using arithmetic, algebraic, geometric, and statistical methods.
- Determine the reasonableness of answers to mathematical problems, identify alternatives, and select the most optimal solution.

In their respective research works that describe the objectives of mathematics education, the National Council of Teachers of Mathematics [NCTM, (2000)], the Mathematical Association of America [MAA, (2003); Sons (1996); Howe (1998), and the American Mathematical Association of Two-Year Colleges [AMATYC, (1995)] all emphasize quantitative reasoning as a skill all students should be able to acquire. Nevertheless, teaching quantitative reasoning goes beyond just teaching computational skills, which may also be necessary for other settings. However, much more, the focus would be to inculcate (1) computational strategy selection and application, as well as (2) determining whether estimations or calculations are appropriate.

An individual who can perform quantitative reasoning can analyze quantitative data. Since many primary and secondary school and college courses are designed to develop close-up reasoning abilities, such as budgeting and shopping, they do not restrict themselves to mathematics. The following six capabilities are included in quantitative reasoning skills, according to Dwyer, Gallagher, Levin, and Morley (2003):

1. interpreting information presented in a variety of formats, such as graphs, tables, geometric figures, mathematical formulas, or texts (e.g., in real-life problems);
2. Making appropriate inferences from quantitative information;
3. Applying mathematics, algebra, geometry, or statistics to solve problems;
4. Checking the reasonableness of answers;
5. Using numerical, algebraic, or graphic representations to communicate quantitative information;
6. Recognizing that methods of mathematics or statistics can have limitations.

This principle underpins active classroom learning: "What I hear, I forget; what I see, I remember; what I do, I understand." The involvement of students in the learning process has been shown to accelerate learning, improve knowledge retention, and enhance critical thinking skills, according to researchers like Himes and Caffrey (2003), Kain (1999), Kenny (1998), and King (1994). It is based on the principle that "students learn mathematics by doing mathematics rather than listening to someone talk about doing mathematics" (Twigg 2005). The teaching of quantitative reasoning is best achieved through the practice of quantitative reasoning, according to this philosophy. Most educators believe the best method of teaching quantitative reasoning is through real-life situations. A concern that students perceive school mathematics as irrelevant to their present and future lives led Burkhardt (2008) to suggest that numeracy is best taught through Problem Solving.

According to Karim and Wakefield (2007), students should have access to a real-life example before being introduced to more general theories. The contextualized use of information is at the core of quantitative reasoning, so these approaches to teaching quantitative reasoning are crucial. There is no evidence in empirical research that conventional remedial mathematics courses improve student achievement (e.g., Lagerlöf and Seltzer 2008; Pozo and Stull 2006). Additionally, Marshall and Swan (2006) and McFarland (2010) have shown that active learning can improve high school students' graphing skills and young children's quantitative reasoning skills. The economics and mathematics departments at Macalester College offered a course that taught fundamental quantitative skills in an applied setting, according to Bressoud (2009).

2.2.4 Quantitative reasoning skill and mathematics

Mathematics and quantitative reasoning are fundamentally related, but mathematics is primarily a discipline, whereas quantitative reasoning is a skill that can be applied to many different situations. Davidson and Mckinney (2011) agreed that quantitative reasoning is inclusive, its language plain and every day, not exclusive, as mathematics is. Although few individuals are trained in complex mathematical concepts, most people have a sufficient understanding of mathematics to form informed opinions about quantitative concepts (Davison and Mckinney, 2011). Although quantitative reasoning differs from mathematical content knowledge, it is necessary (though not sufficient) to understand mathematical content. Quantitative reasoning covers a lot of grounds that pupils with mathematics disabilities would need in and out of school. In this wises Creswell (2016) recommended that all pupils with mathematics disabilities enroll in a quantitative reasoning review course where they can study and practice this skill like other subjects.

According to Ramful and Ho (2015), quantitative reasoning and its application to mathematical problems require understanding the problem statement, formulating a plan or using specific operations to solve a mathematical problem and establishing relationships among the quantities as part of the solution process. Reasoning quantitatively often facilitates this process. As opposed to working with particular values of quantities, it involves understanding the relationships between quantities.

2.3 Concept of guided-discover strategy

Being a teacher requires the dual skills of both knowing the content (subject matter) area and knowing effective method or strategy for teaching the content Teaching mathematics to pupils with learning disabilities requires strategies that make the pupils active participants in the classroom and not just passive listeners. Mathematics provokes more feeling of anxiety and frustration than any other subject for very many primary school pupils with learning disabilities. Classroom teaching ought to meet the needs of pupils, resolve their fears and allow them learn in their own unique way. Guided discovery involves students actively participating in knowledge exploration as part of the teaching and learning process. The purpose of guided discovery is to facilitate students' deep learning - knowledge based on fundamental understanding, often resulting from multiple perspectives. In the process of guided discovering knowledge, students are creating and adding to their scaffolded understanding, according to the pedagogical foundation.

A hypothesis will be formulated and evaluated, rejected if it does not explain observations, misconceptions encountered, and surprises encountered, and finally, an understanding will be reached. Recreating knowledge from existing sources will teach students how to create new knowledge and develop inductive reasoning skills. In recent times a discovery approach to learning mathematics has become the trend in school system. This strategy involves problem-solving; a situation that is designed to encourage pupils to discover the answers without direct instruction from the teacher. The goal therefore has been to make mathematics more meaningful for school pupils.

Constructivist discovery learning involves students using their experiences and existing knowledge to discover new facts, relationships, and truths in problem-solving situations.

According to Kirschner (2009) and Van-Merrienboer and Sweller (2005), guided discovery is not a suitable method for most learners, as they need more knowledge to make a relevant inquiry on their own. According to Sweller (1998, 1999), Van - Merrienboer and Sweller (2005, 2010), novice learners should not be exposed to discovery learning. However, preparing learners to deal with increasingly complex problems may be a long-term objective. Progressive pedagogy is crucial to successful quantitative reasoning instruction: "connecting content to real-life situations, focusing on concepts rather than facts, and integrating content across disciplinary boundaries" (Cuban 2001). Students understand the relevance of quantitative reasoning skills to social issues when theory and data analysis are combined in an active learning setting. Killen (2006) argued that:

> It is now generally accepted that most people learn best through personally meaningful experiences that enable them to connect new knowledge to what they already believe or understand. Such constructivist views of learning have led to a redefinition of effective teaching. It is now more widely accepted that teachers have to deliberately help learners construct their own understanding, rather than simply tell them things that they are expected to memorize. Good teaching is no longer about helping students to accumulate knowledge that is passed onto them by teachers; it is about helping students to make sense of new information (no matter what its source), to integrate new information with their existing ideas and to apply their new understandings in meaningful and relevant ways (p. 3).

In contrast, McLaughlin and Talbert (1993) argued that teachers must learn to differentiate between interactive, constructivist and less demanding, conventional methods when teaching. In addition to providing five significant benefits to learners, quantitative constructs and language are also beneficial (Madison, 2012). (1) enhances academic argumentation; (2) improves quantitative literacy and reasoning; (3) interprets and improves public discourse; (4) encourages quantitative reasoning across the curriculum; and (5) helps students prepare for careers. Researchers studying quantitative reasoning have also demonstrated several benefits of integrating quantitative reasoning into writing programs.

Among its benefits are improving writing instruction, challenging the conventional view that quantitative reasoning is merely remedial mathematics, and facilitating the integration of quantitative reasoning into the school curriculum (Grawe and Rutz 2009). Lutsky (2008) emphasizes the need for connections between writing and quantitative reasoning when making a descriptive argument, framing an argument, or supporting, qualifying, or evaluating an argument. Quantitative analysis can also influence how arguments are marshalled and exchanged." Numbers strengthen language, and the reverse is also true. Researchers have found that developing math and reading can lead to significant success in mathematics (Kirk and Lerma, 2010). With discovery learning, students work freely on tasks with little guidance and discover the lesson themselves. Constructivism is at the heart of discovery learning. According to this theory, learners actively seek to understand their surroundings.

A student's best learning happens when he or she actively asks questions, explores, and builds knowledge. Mayer (2018) reviewed three research bodies to determine how pure discovery learning works. In his review, Mayer distinguished between pure and guided discovery learning. In the pure form, learners are given tasks and problems to tangle with, but essentially no guidance from their teacher. They might work in groups and discuss with other students. Otherwise, they figure it out on their own. Guided discovery learning involves teachers much more. Mayer compared pure and guided discovery learning for the three tasks. Teachers should coach the student, give hints and feedback and demonstrate solution strategies. Teachers systematically guide students towards the learning objectives. In the first task, students discovered problem-solving rules, and the second task taught conservation principles.

A discovery learning approach for teaching computer programming was also discussed in the third article. The third article also discusses a discovery learning approach to computer programming instruction. Mayer discovered that guided discovery learning outperformed pure discovery learning in these carefully tested cases. The main reason that pure discovery learning fails is that students miss important information when given complete freedom to explore. When they learned independently, they also developed more misconceptions, particularly about how computer programs work. Researchers discovered something significant in each of these studies. It is something that adventurers have known for centuries. When venturing into the unknown, having a guide is extremely beneficial.

2.3.1 The need for guided discovery strategy

Learners generally requires good amount of direct instruction in order to accumulate knowledge. Using just minimal guided approach does not lead to effective or efficient learning (Alferi, Brooks, Aldrich and Tenenbaum (2001). For classroom instruction to produce effective learning to meet the needs of pupils with learning disabilities, a guided discovery strategy is required. In this regard, Klahr and Nigam (2014) argued that learners should be provided with a gradual and steady introduction to the learning domain to recognize the signs of new relationships. Second, such a method would enable students to develop skills and cognitive strategies for exploring and experimenting systematically. As learners gain more expertise and can discover insights independently, such a method must gradually decrease support and guidance throughout the discovery process (Mayer, 2004). The only instructional strategy that seems to effectively do this for pupils with learning disabilities in mathematics is the guided discovery strategy.

In guided discovery strategy, instructions are designed to help pupils discover specific concept with maximum teacher guidance. The job of the teachers is to make sure that the pupils are going through the proper progressions to discover answers for themselves. Sometimes the pupils may stray from a predetermined path to discover answers, this is where the teacher has to intervene and guide the pupils through the proper progression. The strategy relies heavily on step-by-step procedure in solving any given mathematics problem, with a series of question to guide the pupils as they progress towards discovering answers or concept.

The University of Minnesota (2013) listed the following as steps for teachers of pupils with mathematics learning disabilities when using guided discovery strategy: Give pupils amply time to work on tasks, only give minimal assistance to those who ask for it, when assisting, use questions that will help pupils recall past knowledge and never give hints on procedural steps. Alfieri, Brooks and Aldrich (2001) defined guided *discovery learning* as finding information independently and using only materials provided to the learner. In this situation, the teacher can provide different types and amounts of guidance. To buttress this, Mayer (2014) observed that unguided discovery is generally unproductive. Caprario (2013) suggested that people learn behaviours and information outside the classroom through what he called "guided participation". Similarly, Alfieri, Brooks and Aldrich (2011) opined that learning like this is so subtle and an integral part of life, even though it is not always noticed. Enhancing discovery skills is truly beneficial in a variety of situations.

Therefore, discovery skills can be acquired and need to be practised from primary school to other higher levels of education. Mayer (2014) reiterated that instructors (teachers) must demonstrate how learners can discover knowledge. According to Caprario (2013), by regularly implementing guided discovery strategies in the classroom, learners will develop this skill that can be used in any situation or activity both within and outside the classroom setting. According to Denton (2018), guided discovery is a method for introducing classroom materials. During guided discovery, pupils explore the possibilities of classroom resources to generate interest and excitement. In addition to introducing vocabulary and assessing pupils' prior knowledge, the guided discovery also teaches responsible use and care of materials (Denton, 2018). Based on Bechtel (2014), the guided discovery could take as little as fifteen minutes or as long as twenty minutes. It does not impede pupils' enthusiasm; they can practice daily skills that facilitate learning. Denton (2014) put forth four goals for the guided discovery strategy:

- Educating pupils about classroom materials
- encouraging them to explore materials with confidence and imagination
- developing a repertoire of constructive ways to use those materials in their academic learning

To develop norms and routines for the use, care, and storage of materials and enable pupils to make independent and purposeful choices. Guided discovery learning strategy is on the continuum of students centred learning and teacher centred (Abdullah, 2018). Pupils are given initial problem, issues or topic to investigate. Pupils therefore understand from hand- on learning, reasoning process and reflection (Clark, 2015).

However, Mayer (2014) and Kirschner, Sweller and Clark (2016) suggested that discovery instructional strategy be used with care as novice learners are likely to find minimal guided discovery activities cognitively overwhelming. They advocated that a high-fidelity learning environment, closely approximating real-world environment are essential.

2.3.2 Benefits of guided discovery strategy

The benefit of a guided discovery strategy can not be overemphasized because discovery is an integral part of human life. Ellis, Basturkmen and Loewen (2012) stated that a guided discovery-based approach to teaching explicit knowledge has much to benefit the learner. There are several benefits to guided discovery strategies: excellent recall of rules learned independently, enhanced problem-solving skills, and cognitive activity. Guided discovery has a profound impact on children's learning. Through the creative use of classroom materials, students become engaged with classroom materials. Working independently and stretching their thinking are opportunities they have. The process revolves around the pupils. In addition to suggesting ideas, taking action and sharing the results of their work with others, the guided discovery strategy encourages children to offer their ideas and take action (Bechtel, 2014). This learning strategy is recommended by Rowe (2014) and Villanueva (2016) because it forces students to manipulate their environment, creates new ideas, stimulates curiosity, and motivates them to solve problems.

There are many strategies and methods available to teachers. These strategies organise and present the learning experiences to school pupils. Dyke (2017) observed that such strategies range from direct, teacher-centred strategies to indirect, more student-centred strategies. In the past, however, direct teacher-centred approaches have been predominantly used in the classroom. Through research efforts, in recent times, there has been a shift towards a student-centred strategy (Simon, 2015). One of the instructional strategies that seem to be entirely students-centred in recent time is the guided discovery (GD) strategy. The guided-discovery strategy is known for positive results in areas of Reading, writing and speaking. A few literature have been sighted (Middleton & Spanias, 2009; Jones & Tanner, 2002; Humphreys & Hyland, 2002) which reported that guided discovery strategy yielded positive results in mathematics instruction. A deliberate use of the strategy in teaching quantitative reasoning may also be productive with pupils with mathematics learning disabilities (MLD).

Generally, the notion that pupils take ownership of their learning in motivation underlines the use of guided discovery in primary school. Guided discovery instructional strategy is a rare form of instruction due to the circular challenge of designing a course with appropriate teacher guidance. In practice, pupils should engage in activities that enable them to apply their prior knowledge to the goal concept by the end of the lesson. According to many cognitive theories, new stimuli are related to existing knowledge in the pupil to construct knowledge (University of Minnesota, 2013).

2.4 Concept of model-lead-test strategy

Mathematicians can benefit significantly from using the model-lead-test strategy, particularly for quantitative reasoning. Teachers use this method by modelling the problem, guiding students through it, and assessing their progress. Model-lead-test (MLT) strategy can be summarized using these words "I do it, we do it, and you do it". According to Price and Nelson (2013), the strategy involves four components: (a) demonstration by the teacher, (b) students follow the demonstration, (c) replicating the demonstration, and (d) the students perform the skills on their own. Model-lead-test instruction is, therefore, a method of explicit instruction. Learners' mental models are developed and evolved through this program. Buckley (2012) states that model learning is an internal representation of the dynamic system components and their interactions, resulting in some emergent behaviour. Learners can better understand the world around them by building, extending, elaborating, and improving their mental models. As Gilbert and Boulter (2000) assert, model-based instruction assumes that mental models are universal ways of thinking and expressed models are universal communication components.

In the model-lead-test (MLT) strategy, students are encouraged to use learning strategies independently by a three-stage instructional process: (1) the instructor (teacher) models the correct use of strategy, (2) students practice the correct use of strategy, and the instructor tests (3) When students achieve 80% accuracy on two consecutive tests, the instruction may cease (Marchand-Martella, Slocum & Martella, 2004). According to Chen (2014), the test teaching paradigm has been used to shape comprehension responses to an independent level without the assistance of an instructor (Idol, 1987). The effects of model-lead-test strategies in teaching a wide range of skills to learners with different disabilities have been demonstrated in recent studies (Derby and Johnson, 2011; Kaufman, McLaughlin, Derby and Waco, 2011; Ruwe, McLaughlin, Derby and Johnson, 2011; Glover, McLaughlin Derby and Bower, 2010; Green, McLaughlin, Derby and Lee, 2010).

2.5 Theoretical review

2.5.1 Information Processing Theory (Miller, 1956).

The information processing theory was developed by Miller (1956). The theory postulated that the human mind receives the stimulus (information), processes it, stores it, locates it, and then acts on it. Miller believed that the human mind could simultaneously hold 5 – 9 chunks of information. As a person receives new information, a sequence of events occurs in his mind that can be studied and analyzed as part of this theory of cognitive development. According to information processing theory, people like computers can process the information they receive from their environment. Instead of simply reacting to environmental stimuli, the human brain, takes in information, processes it, and get it stored, for use in future time. This theory suggested that in the classroom situation, the student receives information and briefly stored in sensory memory, then, moves into the working memory (short term memory) as effort is made to pay attention to that information through repetition or practice the information is further transferred into the long memory where it is stored permanently. Otherwise, it is lost and forgotten at the working memory.

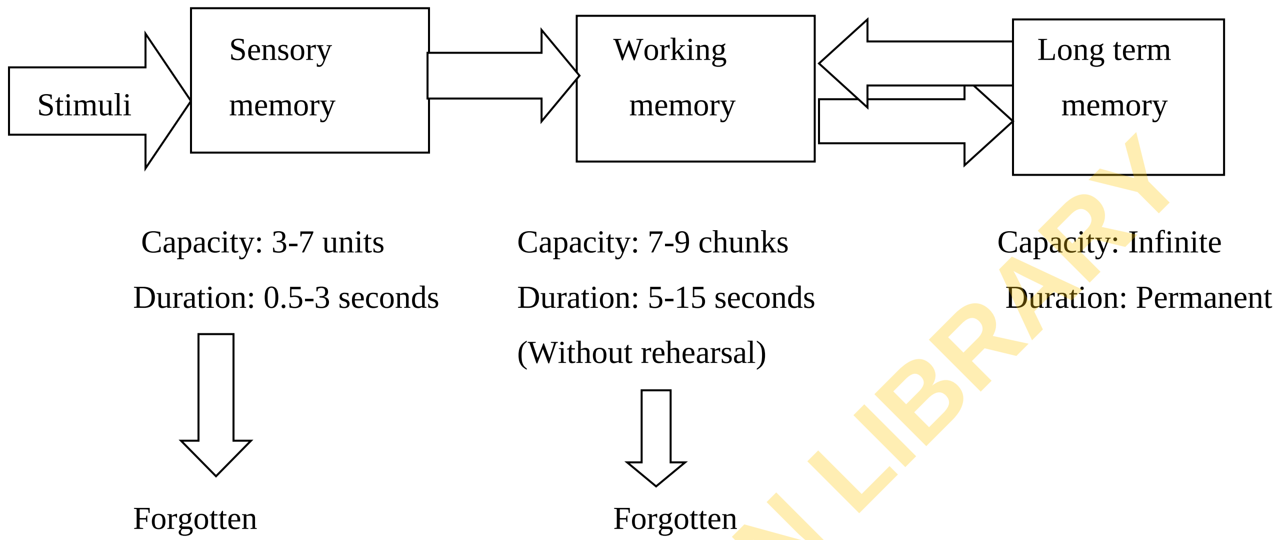

Figure 2.1: Information Processing Mode

Source: htt://dataworks.cd.com/the-information processing model, p.4

Information processing theory suggests that sensory memories, or sensory registers, store information or experiences briefly for a few seconds. The information is immediately lost from the sensory register until there is an effort to pay attention to it. The theory can be put thus: as students take in information, sensory information is first stored, then transferred to short-term memory, after which it is either forgotten or transferred to long-term memory as semantic memories (concepts and general information), procedural memories (processes) and images. A child's brain matures as they grow, improving their ability to process and respond to sensory information. As information cannot rest in short-term memory for too long, it must be registered in long-term memory. In his theory of information processing, Miller (1956) presented two cognitive and information-processing frameworks. Working memory capacity (short-term) and "chunking" were the first two concepts. Any meaningful unit of information is a chunk, according to Miller.

In his opinion, short-term memory (working memory) can hold only five to nine chunks of information (seven plus or minus two). A digit, an object digit, an object, or a person's face can serve as at, or a person's face can serve as a unit of information (chunk). The second is what miller, Galanter and Prinbram (1960) referred to as the concept of Test-Operate-Test-Exit (TOTE). A goal must be tested to see if it has been achieved if it has not been achieved and an operation is performed if it has not been achieved. In this cycle, the goal is achieved until the exit is reached or the goal is abandoned. The relevance of this theory to teaching quantitative reasoning is that at the sensory memory level the pupils must be paying attention, this why the lesson must be planned and structure in a manner that initially spark the attention of the pupils. At the working memory level pupils must be taught to act on the information in the short-term memory so that it is not lost after a while. Several methods are described by Lerner (2000) for extending the life of short-term memory, such as rehearsals and repeating information, chunking and grouping information, and arranging keywords and information (Lerner, 2000, p. 204).

Information processing typically relies on three forms of knowledge: conceptual, procedural, and factual. An individual with conceptual knowledge can understand why a procedure works by forming a relationship between current and new information. By applying rules and procedures, procedural knowledge helps the individual accomplish a task. Factual knowledge, on the other hand, allows students to recall answers from memory without performing any computations. (Voutsina, 2012).

Pillars of Information Processing Theory

Four main pillars support the information processing theory (Psychologie, 2018). There are:

Thinking: Thinking occurs anytime an individual perceives, stores, encodes, represents, and retrieves information.

Stimuli Analysis: This refers to a process where the brain alters the encoded information to suit the process of interpretation and understanding for decision-making. Four sub-processes support this process: encoding, strategizing, generalizing and automation—these contribute to the finalization of encoded stimuli (information).

Situational Modification: This is a process where an individual uses his experience (information stored earlier) to deal with a new situation. Suppose there is a slight difference in the situation. Using his previous experiences, the individual can develop newer ways of dealing with a similar problem without making the same mistakes. An individual faced with a dilemma or task must encode the critical information and then use the past information he has stored (experience) to resolve it.

Obstacle evaluation: At this stage, a person's intellect, cognitive acumen and problem-solving skills are determined. It is also essential to consider the person's developmental level and the complexity of the problem. An individual who receives misleading information may also need clarification or clarity, deterring him from handling a situation successfully, which he might have done sooner.

2.5.2 Social theory of learning - Bandura (1977)

Social learning theory was proposed by a psychologist named Albert Bandura in 1977. According to the theory, learning depends on observation, imitation, and modelling. As a combination of behaviourist and cognitive theories, Bandura's social learning theory stresses the importance of psychological factors. Adding a social element was Bandura's argument that watching others taught people new information and behaviours. In social learning theory, there are three main concepts. Just because something is learned does not mean it will result in a change of behaviour. Observation and internal mental states are essential parts of the learning process.

Bandura (1977) stated that, fortunately, humans learn most of their behaviours through observation and modelling. The idea is that by observing others' behaviours, one can form an idea of how to perform new ones and, later use that coded information as a guide for action. A well-known psychological experiment by Bandura demonstrated that children learn from watching others and imitating their behaviour. Bandura's social learning theory identified three basic models of learning:

1. An individual (instructor) acts out or demonstrates behaviour in a live model.
2. An instructional model in which a behaviour is described and explained verbally
3. Symbolic models involve real or fictional characters displaying behaviour in books, films, television programs, or on the web (Cherry, 2017).

Bandura's social learning theory is relevant to this present study for its provision for guiding the learners and to model target behaviour. The theory emphasized certain steps involved in the learning and modeling process which the two strategies in this study aimed to attain in pupils quantitative reasoning skills. Thus.

1. **Attention:** To teach, one needs to be paying attention; where attention is distracted, learning will be interrupted. Therefore, the model has to be exciting, or there has to be a novel aspect of the situation so the learner is likely to devote full attention to learning.
2. **Retention:** Information needs to be stored in order to be learned. Although many factors can affect retention, the achievement is determined by the ability to recall and act on information later.
3. **Reproduction:** Once the learner has absorbed information from the model, it is time for him to perform the behaviour he has learned. Further practice of the learners' behaviour leads to improvement and skill advancement (Bandura, 1997).
4. **Motivation:** For learner success, the model must motivate the learner to imitate that behaviour. Motivation can be highly effective (Cherry, 2017).

2.5.3 Theory of Guided discovery architecture (GDA) Clark (1998)

Guided discovery architecture theory was first proposed by Clark (1998) as one of the four instructional strategies that were developed to meet human cognitive and performance task needs. GDA theory emphasizes that learners are active constructors of knowledge and play a central role in learning. The instructor's job is to provide resources and experiences that foster the internal construction of new knowledge and skills in guided discovery architecture (Clark, 1998, 2000). During guided discovery architecture (GDA) instruction, learners are immersed in situational contexts where they often manipulate simulation devices. Learners are guided, informed, and given feedback by the instructor, who pre-defines the learning goals, tasks, topics, and resources (Merrill, 2000). There are five main categories of guided discovery architecture (GDA). The five architectures are:

1. Case-based learning
2. Incidental learning
3. Learning by exploring
4. Learning by reflection and
5. Simulations-based learning. (Schanik and Cleary, 1994).

Learners typically benefit from guided discovery architecture once they have gained sufficient expertise in foundational skills. Learning must involve students in complex real-world problems that encourage them to develop transferable and flexible skills (Merrill, 2012).

2.5.4 Bloom's taxonomy of education- Bloom (1984)

Benjamin Bloom developed a taxonomy of educational objectives that consisted of three domains: Psychomotor (doing/hand), cognitive (knowing/head) and affective (feeling/heart). Physical skills, such as dexterity movement and fine and gross motor skills, are evidence of psychomotor learning. Cognitive skills relate to knowing, comprehending, and analyzing a subject matter. Emotions and empathy are the focus of the affective domain. All three domains are interconnected (Bloom, 1984). Bloom himself did not create subcategories of skills in the psychomotor domain. But subsequent researchers (Simpson, 1972; Krathwohi, Bloom and Masia, 1990) created within each domain hierarchical skill set as presented in the table below:

Bloom's Domains of learning (higher order skills are on top)

Psychomotor	Cognitive	Affective
Origination	Evaluation	Characterizing
Adaptation	Synthesis	Organizing
Complex overt response	Analysis	Valuing
Mechanism	Application	Responding
Guided response	Comprehension	Receiving
Set	Knowledge	
Perception		

(Source: Bloom, 1984; Krathwohi, Bloom and Masia, 1990)

Bloom's best-known domain is the cognitive domain and the skill set most central to quantitative reasoning. Bloom's taxonomy outlined six categories of skills in the cognitive domain. Anderson and Krathwohi (2000) described these categories according to the degree of difficulty, from Analyzing and evaluating the most superficial behaviours or "Lower order thinking skills" (LOTS) to the most complex ones, which are the Higher order thinking skills (HOTS). Lower-order thinking skills (LOTS) compress three skills: remembering, understanding, and applying, while the higher-order thinking skills (HOTS) consist of three skills: creating. Bloom's taxonomy has relevance to this study because, when considering quantitative reasoning, Bloom's taxonomy can provide a framework for defining more specific learning outcomes. Suskie (2009) suggested categorizing learning goals into three: (1) Understanding and knowledge, (2) Thinking skills, and (3) Values and attitudes.

2.6 Empirical review

2.6.1 Model-lead-test strategy and quantitative reasoning skill

For Pupils with mathematics disabilities in primary schools, early intervention is an effective way to reduce the impact of disabilities on pupils in later life (Howard, 2013). Pupils with learning disabilities in mathematics, therefore, require valuable teaching strategies during their early developmental stage in primary school. Model-lead-test strategy fits the needs of this set of pupils. The strategy emphasizes the need to teach functional skills in a natural environment to maximize achievement (Shouse, Weber, Mclaughlin & Riley, 2012) Model-lead-test strategy has proved effective with students with developmental disabilities. Martensen, McLaughlin, Neynab and Girshick (2013) investigated the effectiveness of model-lead-tests with rewards in teaching preschool pupils with language and developmental delays the concept of number quantity. Participants were taught number quantity by using a model-lead-test error correction strategy. Three groups of numbers were analyzed using multiple baseline designs. In general, the model-lead-test with reward resulted in improved performance by the pupils. Participants showed an increase in the number of correctly answered questions between the first and last sessions.

Quantitative reasoning skills are crucial in everyday life. Understanding the concept and mastering and achieving the skills are essential for contributing to society. It may be a struggle for pupils with mathematics disabilities to master and achieve quantitative reasoning skills. Al-Dahri, Mclacighlin, Derby, Belcher and Weber (2013) conducted a study to evaluate the effect of direct institution Model-Lead-test strategy on rote counting, number recognition and rational counting with preschool students with developmental delays. The study design was a combination of multiple baselines and an ABC design for member identification. A description of the various phases then followed. The model-lead-test (MLT) strategy with reward was used to help the participants across all three tasks. It was used for rote counting for 4-14 sessions, number recognition for 6-14 sessions, and rational counting for 7-14 sessions. Using model-lead-tests with rewards, the participants made progress.

The model-lead-test (MLT) strategy effectively taught rote memorization and rational counting. Research on model-lead-test strategies with students with developmental disabilities and autistic spectrum disorders has been published (Chandler, Mclaughlin, Derby, Veyman and Rinaldi, 2012; Travis, Mclaughlin, Derby, Dolliver and Carosella, 2012; Herberg, Mclaughlin, Derby, Dolliver and Carosella, 2012; Herberg, Mclaughlin, Derby and Gilbert, 2011) and recorded some success and effectiveness. In the same vein, it is hoped that when applied to pupils with mathematics disabilities, their quantitative reasoning skills will be significantly enhanced.

A significant amount of mathematically related play is conducted by primary school children (Mccain and Mustard, 2009). During this type of mathematical play, children would be encouraged to explore patterns and shapes, compare objects based on size, and develop an understanding of numbers. With age, mathematically related play becomes problem-solving, and children use models to communicate their understandings as they relate and use models to solve problems. Carpenter, Ansell, Franke, Fennema and Weisbeck (2013) stated that:

> If we could help children to build upon and extend the intuitive modeling skills that they apply to basic problems as young children, we would have accomplished a great deal by way of developing problem-solving abilities in children in the primary school. Furthermore, modeling

> provides framework in which problem solving becomes a sense making activity (P. 440).

The application of skills is one of many components of problem-solving. Thinking critically and reasoning quantitatively are required for problem-solving. Teachers generally begin by presenting the problem to students, then students explore and develop solutions, and then teachers and students consolidate and reflect on the solution (Bowman, Donovan and Burns, 2001). Analyzing and solving problems is generally regarded as one of the most important 21st-century skills (Wagner, 2008). This skill is believed to be embedded in quantitative reasoning hence exposing pupils to quantitative reasoning early can boost the development and achievement level in mathematics. Quantitative reasoning has become an indispensible skill for modern society. Bransford, Brown and Cocking (2000) summarize the situation as follows.

> In the early part of twentieth century, education focused on the acquisition of literacy skills: sample reading, writing and calculating. It was not the general rule for education system to train people to think and read critically, to express themselves clearly and persuasively, to solve complex problems in science and mathematics. Now, at the end of the century, these aspects of high literacy are required of almost everyone in order to successfully negotiate the complexity of contemporary life. The skill demands for work have increased dramatically, as well as the need for organization and workers to change in response to competitive workplace pressure. Thoughtful participation in the democratic process has also become increasingly complicated as the focus of attention has shifted from local to national and global concern (Pp. 4-5).

It was found in a survey conducted by the American Association for Colleges and Universities (AAC&U, 2014) that employers are also concerned about quantitative reasoning achievement, as many of today's students will need a wide array of high-level quantitative skills to succeed in their careers. Students must be able to draw information from charts, graphs, and geometric figures and accurately calculate and estimate (Hesh and Keeping, 2013). To enhance students' quantitative reasoning achievement, Furlong (2013) designed and implemented active learning modules by incorporating group base learning with model-lead-test strategy. The result showed that the active learning strategies were useful in enhancing quantitative reasoning skills. Similarly, Zhou, Ma, Huang Liang, Yue and Peng (2012) designed, implemented and evaluated a Web Quest and integrated model-lead-test strategy for chemistry classroom teaching to improve quantitative reasoning achievement of high school students.

The results showed that integrating Web Quest- model-lead-test into science classroom teaching was an effective way to enhance high school students' quantitative reasoning achievement. Both general and special education students have benefited from the use of model-lead-test. In Chen (2014), the effects of model-lead-test coaching were investigated on parents' implementation of reinforcement, prompting, and fading with their children with autism spectrum disorders. A model-lead-teat (MLT) coaching approach was used to evaluate parents' use of prompting, fading, and reinforcement for their children with autism. It was assessed whether parents used these behaviour-change processes to improve their children's communication, participation, and problem-solving abilities.

Baseline, parent training (oral lecturer), parent training II (model-lead-test), and maintenance phases were all included in the research. Using the model-lead-test approach to parent training resulted in a more significant impact than using oral lectures and discussions alone. Furthermore, the model-lead-test method was more effective in implementing reinforcement, prompting, and fading. In many educational settings, the model-lead-test is used. Currently, no studies have examined the impact of model-lead-tests on quantitative reasoning achievement among learners with disabilities.

2.6.2 Guided discovery strategy and quantitative reasoning skills

Students can take an active part in their learning through guided discovery. In this way, students can "discover" new material as if they were the first to reach these conclusions. They benefit from being exposed to it for the first time. Moreover, the presence of a guide ensures that students can take advantage of exploratory learning without wasting time on unnecessary activities. Learning is most effective when pupils can connect new knowledge with what they already know or believe (Cuban, 2011). As a result of this constructivist view of learning, effective teaching has been redefined so that teachers can assist learners with learning disabilities in understanding instead of just telling them what to remember. According to researchers, good teaching does not consist of passing on knowledge to students (Brooks and Brooks, 2011; Lenard, 2012; Switzer, 2014; Calkin, 2018).

Creating meaningful and relevant connections between new information and existing ideas is part of the process of helping students make sense of new information and integrate it with their existing ideas: As a result of a survey study conducted by the Organization for Economic Co-operation and Development [OECD,(2013)], adults aged 16-65 from Japan, Finland, and Belgium scored the highest on numeracy skills among the 23 OCED member nations surveyed. As a result, Americans, Italians, and Spanish scored lowest. The highest scores were achieved by Finland, the Netherlands, and Korea among young adults ages 16-24, while Italy, Cyprus, and the United States achieved the lowest scores. In developing and developed countries, school pupils have a wide quantitative literacy gap (Aud, Fox and Kewal Ramani, 2010). Steen (2001) has argued that:

> Most U.S. students leave high school with quantitative reasoning achievement far below what they need to live well today; business lament the lack of technical and quantitative skills of prospective employees and virtually every college finds that many students need remedial mathematics (Pp. 1-2).

This provides the very essence for a search for instructional strategy that can effectively enhance pupils' quantitative reasoning skills. To this effect guided discovery strategy comes to play in this study. A guided discovery strategy was developed based on a study demonstrating that learning is inherently constructive. In Pashler (2010), the role of the teacher when employing a guided discovery strategy is to provide learners with opportunities to construct knowledge by placing them in authentic situations that require active and personal sense-making. A guided discovery strategy reduces the amount of unnecessary information that can interfere with successful learning (Moreno and Mayer, 2000). The shear strain was explained in a guided discovery method by Sachs (2018). The angle of two-line elements initially perpendicular in the original element changes when stress is applied parallel to the element's face.

This guided discovery during class proved to be an extremely enlightening experience for the students. Following the instructions, students worked in pairs to derive a formula for shear strain based on the provided instruction sheet. Students predicted what would happen when the foam tubes were twisted at 90-degree angles, then analysed whether their predictions matched reality and why. This learning method created cognitive dissonance as students sometimes faced the fact that their predictions did not match the observed reality. Their engagement and value in learning what shear strain is and how it works increased as they interacted with the materials and discovered the knowledge. A more precise understanding of the material allows students to solidify the fundamentals and, more importantly, recreate knowledge. It trains students in inductive rather than deductive reasoning – the more common instruction in classrooms - and has even been shown to be robust against the instructor, instructor experience, and class size.

After class, students often need to review the material to improve their understanding. The students left class without fully understanding what happened because they had to engage throughout the course entirely. Active participation in the learning process helps students pay attention and retain information more effectively. Students learning can be affected by this. Learning through guided discovery can assist students in grasping fundamental concepts even when they leave school and understanding the material even after they leave school.

2.6.3 Gender and quantitative reasoning skills

Achievement disparities between male and female students have been documented in many scientific areas of study. Several countries have documented subtle differences in gender-based performance and participation in mathematics courses (Leder, 2015). Some countries with a long-standing history of gender disparities in mathematics and general school achievement have implemented new legislation and particular interventions based on this documented disparity (UNESCO, 2010). Parity and equality are two dimensions of gender disparity. Girls and boys should have equal access to education (UNESCO, 2012). In contrast, *gender equality* is defined more broadly as gaining access to and participating in education, benefiting from gender-sensitive and gender-responsive educational environments, and obtaining meaningful educational outcomes. Educated people are more likely to participate in economic, social, and political development. In this context, UNESCO (2012) views gender parity as the first step towards gender equality.

African females were encouraged to study mathematics and pursue science and technology in the millennium goals. However, research findings on gender and mathematics education in Nigeria and Africa still showed a wide gap (Nouzha, 2011). Historically, religion, culture, and history have impacted girls' education significantly. These sociocultural barriers are more pronounced when they come to scientific, technical and vocational education and are, unfortunately, tragic when they concern mathematics education and the girl child (David, 2011). Approximately 52.3% of girls and 60.7% of boys in Sub-Saharan African countries are enrolled in primary school (Nouzha, 2011). In addition, he noted that secondary school dropout rates are high among girls.

In mathematics education, research on gender has produced exciting findings. The performance test has been analyzed for gender differences in some studies (Gaidsman, 2015; Ursini, 2010 and Bosch and Trigueros, 2016), while others (e.g. Rivera, 2013; Gonzalez, 2013 and Campos, 2016) have studied a specific topic, spatial visualization, and mathematics teachers' differential relationships with male and female students. It was also essential to consider the attitudes of girls and boys towards mathematics and the use of technology to teach and learn mathematics. Gaisman (2015) observed a trend toward reducing the gender gap in education at all levels and fostering educational equity in developing educational policies.

UNESCO (2010) reported that male literacy rates were 71.6% and female literacy rates were 53.6% in Sub-Saharan Africa. Males and females in North Africa scored 76.7 and 58.1, respectively. The report upheld that in the following ten countries, more than half of the adult population is still illiterate: Gambia 55%, Senegal 58%, Benin 59%, Sierra Leone 60%, Guinea 62%, Ethiopia 64%, Chad 67%, Burkina Faso 71% and male 74%, (UNESCO, 2010: No 3). Nouzha (2015) investigated gender enrolment in schools in Sub-Saharan Africa and found that the net enrolment ratio in the primary school age population was around 52.3% for girls and 60.7% for boys, except for a few countries where almost all girls of primary school age are enrolled in school. He further found a substantial dropout among girls at the secondary school level. Various sociocultural factors have been attributed to this, including early marriage, financial difficulties, institutional barriers, and poor performance of girls (Nouzha, 2015).

2.6.4 Mathematics Anxiety and Quantitative Reasoning Skills

Attention of mathematics teachers and researchers alike have been drawn to mathematics anxiety experienced by young people and adults in recent time. Unfortunately, research done in the past only focused on secondary schools, tertiary institution students and adults. Children of primary school age have not got much attention of researchers. Amongst all school subjects mathematics is one that is most dreaded and evokes anxiety in young children causing avoidance and truancy in school. School phobia may be normal experience for young pupils but anxiety that is triggered by mathematics can be extreme and may inhibit performance.

Mathematics anxiety typically occurs at two levels – high mathematics anxiety and low mathematics anxiety. Wang, Hart, Kovas, Lukowski, Soden, Thompson, Plomin, Mcloughlin, Bartlette, Lyons and Petrill (2014) found that children with high mathematics anxiety are significantly slower and less accurate on mathematics problems than those with low mathematics anxiety. Jameson and Ross (2011) investigated mathematics anxiety in children in lower, middle and upper primary classes. Their findings showed that most pupils experience high level of mathematics anxiety and pupils with high mathematics anxiety had more negative attitude towards mathematics and those with high mathematics computation anxiety, scored lower than pupils with low mathematics anxiety. The nature of association between mathematics anxiety and performance seem not to be clear but some studies such as Maloney, Risko, Ansari and Fugelsang (2010), Cipora, Szczygiel, Willmes and Nuerk (2015) showed that poor performance and failure lead to mathematics anxiety.

Jameson (2013) found it particularly evident in adolescence and adult but found no significant difference among early elementary children. Mathematics anxiety may have adverse negative effect on pupils, Okafor and Anaduaka (2013) and Jameson (2013) reported in their studies that students with mathematics anxiety suffer low self-efficacy in mathematics and may experience low self-esteem resulting from their anxiety. Mathematics anxiety may be caused by many other factors but Dowker, Bennett, and

Smith, (2012), Lerner and Friesema (2013) and Finlayson (2014) aptly agreed that most often than not, mathematics anxiety is created in the classroom. Price (2015) stated rightly that anxiety about mathematics which arises in primary and secondary schools accompany students to college mathematics classroom.

This present study therefore sought to examine the effect of mathematics anxiety of pupils with mathematics disabilities on their quantitative reasoning skills. Teachers can play a significant role in reducing mathematics anxiety in children and help them to approach mathematics with confidence. The best way to overcome mathematics anxiety is for pupils to get the mastery of the subject. As pupils understand mathematics concept more and gain master, the less anxious they will be about mathematics.

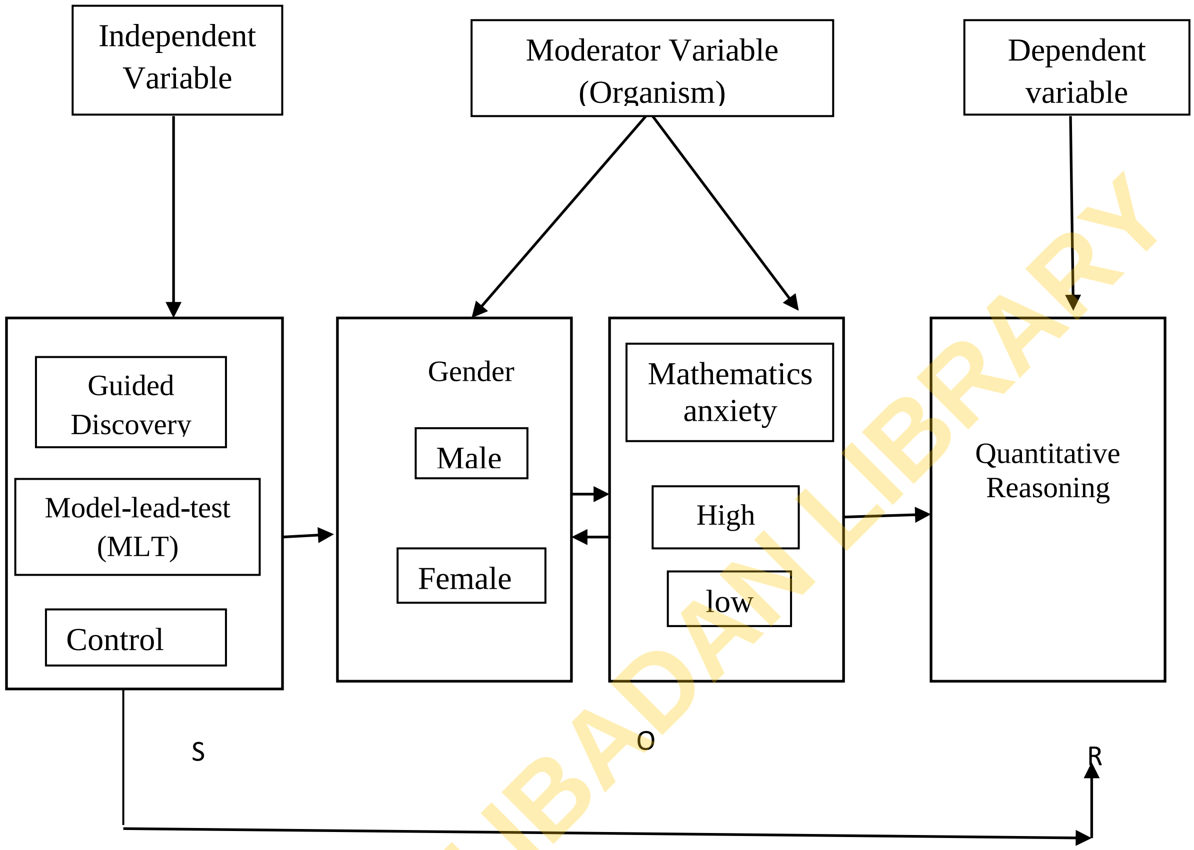

Figure 2.2: Conceptual Framework

KEY: S – Stimulus, O – Organism, R – Response

The conceptual model of this study shows the process by which the study will be conducted. The model indicated the independent variable that will be manipulated – guided discovery (GD), model-lead-test (MLT) and the control group. Also indicated in the conceptual model are the intervening variables which have been captured in the study as moderating variables. They are gender – males and females, as well as mathematics anxiety which also occurred at two levels – high and low. It also showed the dependent variable which is quantitative reasoning skills of primary school pupils

2.8 Appraisal of literature

This study reviewed literature conceptually, theoretically and empirically. The literature reviewed revealed that mathematics disabilities is a specific learning disability that inhibits an individual's ability to learn, understand and use basic mathematics skills. Mathematics disability is prevalent among school aged children leading to the generally perceived poor performance in mathematics. Mathematics disability is caused by known and unknown factors. The know factor is the disorder that affect the brain's ability to receive and process information which makes it difficult for a person to learn quickly or in the same way as those without learning disabilities.

Literature reviewed on quantitative reasoning revealed that quantitative reasoning skills are very important skills that all school age children must possess in order to succeed in school and later life endeavours. Quantitative reasoning and mathematics are synonymous, be that as it may literature revealed that while mathematics is primarily a discipline quantitative reasoning is a skill with practical and everyday application in real life situation. Learner with poor quantitative reasoning skills will also do poorly in mathematics. Adequate quantitative reasoning skills equip pupils not only for mathematics achievement but also overall school achievement hence quantitative reasoning skill is a must for all school pupils their disabilities notwithstanding.

Literature reviewed on instructional strategies reveal that guide discovery (GD) and model-lead-test (MLT) strategies are effective for improving students' performance in other areas of mathematics difficulties. Few studies are available on quantitative reasoning skills for pupils with learning disabilities in mathematics. Literature indicated the need for a specialized instructional strategy for teaching quantitative reasoning skills to pupils with mathematics disabilities hence this researcher deemed it necessary to examined guided discovery (GD) and model-lead-test (MLT) strategies. Literature reviewed on gender and mathematics anxiety revealed a difference between male and female performance in mathematics visa-vise their level of mathematics anxiey. Literature consistently showed that gender and mathematics anxiety have moderating effect on school achievement of persons with learning disabilities.

CHAPTER THREE

METHODOLOGY

The methodology used in this study is discussed in this chapter. It involved the research design, the population of the study, sample and sampling technique, instrumentation, data collection and analysis procedures.

3.1 Research Design

This study adopted the 3x2x2 factorial matrix of pretest-posttest, control quasi-experimental design. Using this design, the researcher established the causal relationship between the independent and dependent variables. The factorial matrix is shown as follows:

Experimental group I (E_1) O_1 X_1 O_4

Experimental group 2 (E_2) O_2 X_2 O_5

Control group (C) O_3 O_6

Where, O_1, O_2 and O_3 represented experimental groups 1, 2 and the control pretest score respectively. Similarly, O_4, O_5 and O_6 represented the experimental groups 1, 2 and control group posttest score respectively. While X1 represented experimental group I treatment (Guided discovery strategy), X_2 is experimental group 2 treatment (model-lead-test strategy), and C represented the control group.

Table 3.1: Factorial matrix table (3 x 2 x 2)

Treatment	Gender			
	Male		Female	
	Mathematics anxiety			
	High	Low	High	Low
Guided discovery strategy (T1)	3	5	8	4
Model-lead-test strategy (T2)	2	7	6	5
Control group (C)	4	5	6	5

Source: Researcher (2021)

The table I showed the treatment at three levels – T1, T2 and C. The moderators: gender at two levels – male and female while mathematics anxiety is also at two levels – high and low. In summary this showed a 3 x 2 x 2 factorial matrix.

3.2 Population of the Study

The population of this study comprised all 4,775 primary 5 pupils with mathematics disability in Uyo Senatorial District of Akwa Ibom State. Uyo Senatorial District comprised nine Local Government Areas namely Uyo, Etinan, Nsit Ibom, Uruan, Nsit Ubium, Itu, Ibiono Ibom, Nsit Atai and Ibesikpo Asutan

3.3 Sample and Sampling Technique

The sample size of this study comprised 60 primary five pupils with mathematics disability. The participants were drawn through multi-stage sampling procedure involving screening of participants. The first stage three (3) Local Government Areas randomly selected out of nine Local Government Areas in Uyo Senatorial District. At stage two a total of three (3) schools were selected by random selection, one school from each of the three Local Government Areas. Stage three was teacher nomination, where teachers who must have been with the pupils for at least six months were made to nominate pupils that were suspected to have learning disabilities. At stage four all the pupils nominated were screened using the pupils rating scale by Myklebust (1981) to ensure only those with learning disabilities were nominated. Stage five, all the pupils screened for learning disabilities were further screened using Slosson Intelligence Test (SIT-R) to ensure only those whose Intelligent Quotients are within the range of (100 – 115) learning disabilities were selected. Stage six was screening for mathematics disability using Kaufman Test of Educational Achievement (KTEA-II) to ensure only those with mathematics disability were selected. Stage seven, was screening for mathematics anxiety using the mathematics anxiety scale for children (MASC) to ensure those included in the study also have mathematics anxiety. Stage eight, was screening for quantitative reasoning deficit using the Quantitative reasoning Deficit Scale (QRDS) to ensure that all the pupils participating in the study have deficit in quantitative reasoning. At the final stage, after all the screenings have been done in each of the schools earlier selected, 20 pupils were randomly selected from each of the three schools using the cap and hat method, where "Yes" and "No" were written on pieces of papers and folded for all the pupils to pick without replace it. All those that picked the yes were taken to participate in the study. This gave a total of 60 pupils who participated in the study. Therefore at the final stage twenty (20) pupils identified with mathematics disability, mathematics anxiety and quantitative reasoning skills deficits were randomly selected from each school, giving a total of 60 pupils that participated in the study

Table 3.2: Selection of participants (Sample frame)

S/N	Schools	No. of teacher nomination	No. of pupils with LD	No. of pupils with Math Disability	No. of Quant. Reasoning Defi	No. of sample
1.	WestItam primary sch, Itu	46	41	29	26	20
2.	St. Andrew primary sch. Uruan	38	31	31	31	20
3.	Q I C primary sch. Ibesikpo	52	37	31	30	20

3.4 Instrumentation

Six instruments were used in this study. They were

1. Slosson intelligent test – revised (Slosson, 2005)
2. Pupils rating scale revised – Myklebust (1981)
3. Kaufman test of educational achievement 2nd edition [KTEA-II, (2004)] - adapted
4. Mathematics anxiety scale for children [(MASC),
5. Quantitative reasoning deficit scale (QRDS)
6. Quantitative Reasoning Achievement Test (QRAT)

3.4.1 Description of Instruments

3.4.2 Slosson intelligence test – revised 3rd edition [SIT-R, (2005)]

This instrument was used to determine pupils' intelligent quotient (IQ) to ensure that only pupils with within the range of learning disability are used in the study and to avoid the error of including pupils with mild intellectual disability. Slosson intelligence test has a long-standing history of distinguished use in a variety of professional setting. It is known to be a quick, valid and reliable measure of intelligence. Slosson intelligence test was designed to test general intelligence quotient, designed by Slosson in 1961 re-normed in 1981 and revised in 2005. It is an individual screening intelligence test which involves determining the individual's chronological age by subtracting the birth date from the date of testing. The basal age is determined after questions involving ten passes in a row. When ten in a row is missed the testing is completed and the ceiling item determined. After the test administration, the tester would obtained the mean age equivalent (MAE) score and total standard score (TSS)

Slosson intelligence test (SIT-R) is a foreign test but Oduolowu (1998) and Oyundoyin (2004) adapted the test by changing certain words to suit the cultural affinity of African testees, while the content validity remained unchanged, it showed a validity coefficient of 0.96. Concurrent validity coefficients were calculated separately for each age level and ranged from 0.90 to 0.98. Passage of time may have affected the above validations therefore this researcher deemed it necessary to re-validate the scale and a reliability coefficient of 0.89 was obtained showing a high reliability. The test therefore is adopted as screening test of intelligence specifically measuring six domains – vocabulary, general information, similarities and differences, comprehension, quantitative and auditory memory. Pupils who obtained scores from 100 to 115 are judged to have learning disability since pupils with learning disabilities normally have average or above average intelligence. This test was therefore used to assess the intelligence quotient of the pupils.

3.4.3 Pupils' rating scale revised – Mykubust (1981)

The pupils' rating scale is a standardized assessment tool for identifying pupils with learning disabilities. The pupils' rating scale was designed by Helme Myklebust in 1971 and revised in 1981. The scale consisted of five major behavioural characteristics: auditory comprehension, verbal communication, spatial awareness, motor coordination and personal-social behaviour. The scale consists of 24 items with which the teachers rated the pupils on the scale of 1 to 5. Where 1 indicates poor behavour, 3 average behaviour and 5 good behaviours. The highest possible score obtainable is 120 (5x24), an average score of 3 points for each question would yield a score of 72 (3x24) while the least possible score obtainable is 24 (1x24). For this study a score below 60 points indicates the presence of learning disabilities.

This scale has been proven to be accurate in identifying pupils with learning disabilities in Nigeria. A reliability coefficient of 0.86 was obtained by Ikujuni (1995) after revalidating the instrument in Nigeria. Similarly, Kanu (2004) and Lazarus (2009) used the scale to screen children for learning disabilities obtaining reliability coefficient of 0.74 and 0.76 respectively. Adekanmi (2011) also adapted the scale to screen children for LD and found it suitable with inter item correlation coefficient of 0.90. Recently Adesokan (2017) revalidated this instrument and recorded a reliability coefficient of 0.90 indicating a high reliability of the scale in identifying children with learning disabilities. This present study therefore, adapted the pupils rating scale to screen pupils for learning disabilities.

3.4.4 Kaufman test of educational achievement 2nd edition (KTEA II, 2004)

The Kaufman test of educational achievement second edition provides a thorough assessment of the key academic skills in mathematics, written language, and oral language. It is a short measure of achievement ideal for screening pupils for mathematics disabilities. It includes three subtest areas but only the mathematics – computation and application problems section was adapted for screening participants for mathematics disabilities in this study. This test consists of 15 items which test seven areas of mathematical competence. A score below 50 indicates the presence of mathematics disability. The researcher pilot tested this instrument and found it to be highly reliable with a reliability coefficient of 0.74. This instrument was therefore used in this study to screen pupils for mathematics disability.

3.4.5 Mathematics anxiety scale for children (MASC) – Chiu and Henry (1990)

The mathematics anxiety scale for children (MASC) was developed by Chiu and Henry (1990) for measuring mathematics anxiety in young children in early, middle and upper elementary school pupils. It is a 22 – item mathematics anxiety scale for children. It was based on mathematics anxiety rating scale (MARS) but shortened for use with children in upper elementary school. The mathematics anxiety scale for children (MASC) uses a 4-point Likert type scale and has a good evidence based on internal structure and a strong evidence based on relations to other variable such as test anxiety and school achievement motivation. Jameson (2016) validated this instrument with children with mathematics anxiety and obtained a coefficient of 0.92, showing a high reliability for measuring mathematics anxiety among young children. This study therefore adapted this instrument as a screening tool for pupils with mathematics anxiety.

3.4.6 Quantitative reasoning deficit scale (QRDS)

The quantitative reasoning deficit scale is an instrument that measures the level of reasoning of children in a quantitative scale. It was designed to be used with children in upper primary classes. The instrument is divided into two parts, the first part was meant to collect the demographic data of the respondents while the second part consisted of 25 items to measure the quantitative reasoning of the respondents. Respondents who score below 40% on the instruments were judged to have quantitative reasoning skills deficit. This instrument was used to screen pupils with quantitative reasoning skills deficit. This scale consisted of 25 items. Each item is scored 4 points. The total highest score obtainable is 100 points. A score below 50 indicates the presence of quantitative reasoning deficit. Hence only pupils who were found to have quantitative reasoning skills deficit were selected to participate in this study.

To ascertain the reliability of this instrument, it was pilot tested on 30 pupils with mathematics disability from other schools that were not part of those to participate in the study. The test-retest reliability method was used in the pilot test, by so doing the instrument was administered twice to the same pupils and the data collated were then analysed. After the first administration of the instrument, a two weeks gap was given before the researcher re-administered the instrument to the same pupils but with the numbering rearranged. A Grombach Alpha coefficient of 0.88 was obtained from the data generated from these two test sessions, indicating high reliability. The instrument was therefore regarded as being reliable for use in this study.

3.4.7 Quantitative reasoning achievement test (QRAT)

Quantitative reasoning achievement test (QRAT) is a researcher made instrument that was used for data collection during the pretest and the posttest exercise. The instrument is in two sections. The first section contained personal information of the respondents while the second section contained 25 questions on quantitative reasoning each item is scored 4 points. The highest score obtainable is 100. To ascertain the reliability of this instrument the researcher carried out a test-retest reliability check. The instrument was administered on 30 pupils with mathematics disability who were not part of those participating in the study. Two weeks after the first administration of the instrument the researcher re-administered the instrument to the same pupils but with the numbering reordered. Data generated from these two sessions of test were subjected to statistical analysis of Gromb1ach Alpha and the coefficient is 0.75 was obtained indicating a high reliability. The instrument was therefore regarded as being reliable for data collection for this study.

3.5 Procedure for Data Collection

With the letter of recommendation from the Department of Special Education, Faculty of Education, University of Ibadan the researcher approached the state ministry of education to obtain permission to carry out the study in the selected schools. With the permission granted the researcher personally visited the schools to obtain permission and approval from the school authorities to enable the researcher use their schools for the study. Once the permission was granted the researcher proceeded to do the following:

1. Screen the pupils for LD using the revised pupils rating scale.
2. Screen the pupils identified with learning disabilities for mathematic disabilities using the Kaufman test of educational achievement 2nd edition (KTEA-II).
3. Screening of pupils for quantitative reasoning skills deficit using the QRDS.
4. Training of three (3) research assistants.

The screening exercise and pretest lasted for two weeks

After the screening was completed, the pupils identified as having learning disabilities in mathematics were randomly grouped into three (3) groups, namely:

- Experimental group 1 – to be treated with the guided discovery strategy
- Experimental group 2 – to be treated with the model-lead-test strategy

Control group – this group remain in the conventional classroom where the conventional strategy was used with them. At the end of the screening exercise the researcher proceeded to administration of pretest to the three groups of pupils. The training of research assistants and administration of pretest followed and lasted for two weeks. The actual treatments for the experimental groups 1 and 2 then started and lasted for eight (8) consecutive weeks. This involved two contact period of thirty-five (35) minutes per contact. After these eight weeks of treatment using Guided-discovery strategy for experimental group 1 and the model-lead-test for experimental group 2, the researcher used the last one week to administer the post-test to the three groups of pupils. Data that were generated from the pretest and posttest using pupils Quantitative Reasoning Achievement Test (QRAT) was then subjected to statistical analysis.

3.5.1 Treatment procedure

Table 3.3: Plan of activities

Week	**Activities**
1	• Familiarisation, recruitment and training of research assistants • Selection of pupils through teacher nomination • Administration of pre- test
2	• Screening of pupils to determine those with learning disabilities using the Pupils rating scale and Slosson intelligence test • Screening of pupils to determine those with mathematics disabilities using Kaufman test of educational achievement
3 – 10	• Actual teaching of quantitative reasoning to pupils using the treatment packages
11	• Administration of posttest

3.5.2 Description of treatment packages

The treatment package s for Guided discovery (GD) and Model-lead-test (MLT) strategies and control group (conventional lecture method) were introduced to the pupils.

3.5.3 Guided discovery strategy

The following procedure was employed for treatment with guided discovery (GD) strategy. This consisted of two contact (lesson) periods of 35 minutes per week.

Objective: objectives was set in line with lower cognitive skills like knowledge, comprehension and application (including practical application)

Presentation

Step one: The teacher welcomes the pupils to the class and guides them to play a simple game to enhance their alertness during the teaching session. Homework given in previous session was treated and corrected in class. Thereafter the teacher introduces the new topic for the day.

Step two: The teacher writes a quantitative reasoning problem on the board, asks the pupils to study it and understand the problem.

Step three: The teacher guides the pupils to formulate series of logical and sequential questions that will help them discover the procedure involved in the problem.

Step four: The teacher guides the pupils step by step to discover the solutions to the problem for themselves

Summary and conclusion: The session was concluded with a recap of the main points especially as it relates to operations in real life outside the classroom.

Homework: The pupils were given take-home assignment in order to apply the strategy independently and to prepare them for the next session.

3.5.4 Model-lead-test (MLT) strategy

Objectives: objectives was set in line with lower cognitive skills such as knowledge, comprehension and application with practical life application

Presentation

Step one: The teacher welcomes the pupils to the class. He leads them to play a simple mathematical game to get them set for the day's work. After that the teacher introduces the new topic for the day.

Step two: The teacher writes down a quantitative reasoning problem on the board. The pupils and the teacher study the problem together in order to understand what mathematical operations are required to solve the problems.

Step three: The teacher **models** the procedure involved in solving the problems and engage the pupils in thinking through the process of modeling.

Step four: The teacher **leads** the pupils to apply the strategy to solve quantitative reasoning problems. This stage is called "we do it together"

Step five: The teacher **tests** the pupils by allowing them ample time to solve the problem independently. This stage is called "you do it"

Summary and conclusion: The teacher summarises the lesson by recapping the process of modeling, leading and testing in order to clarify areas of difficulty.

Homework: Pupils were given take-home assignment for practice and preparation for the next session.

3.5.5 Control group (conventional lecture method)

The treatment here includes the following steps:

Step 1: The teacher introduces the lesson by asking the pupils questions on the previous lesson.

Step 2: Pupils listen passively as the teacher discusses the new lesson's content

Step 3: The teacher evaluates the lesson by asking pupils oral questions to ascertain the change in the initial change in their quantitative reasoning skills of the pupils

Step 4: The teacher gives a brief oral review of the lesson taught. Thereafter the teacher asks the pupils to write the content notes.

The teacher then gives a take home assignment to pupils.

3.6 Method of Data Analysis

The stated hypotheses were tested at a 0.05 level of significance using Analysis of Covariance (ANCOVA). A Scheffe Post-Hoc analysis was used to isolate the source of the significant main effect of the independent and moderating variables on the dependent variables.

Ethical consideration

Researchers invited parents to attend a specific school day with the researchers to explain the purpose of the study. Following research ethics, a teacher who is also a research assistant explained the consent form's content to the participant's parents in their native language. After establishing adequate understanding, each parent completed and signed a consent form. The profiles and responses of participants were kept confidential. Study limitations include no recording of sessions.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

The results of data analysis are presented in this chapter in relation to the hypotheses that have previously been formulated and tested, along with a discussion of the results. The results are presented under the following headings, demographic data analysis, testing hypotheses, summary of findings and discussion of findings.

4.1 Demographic characteristics of participants

Table 4.1: Participants demographic characteristics

Gender distribution		
Gender	**Frequency**	**Percentage**
Male	26	43
Female	34	57
Total	**60**	**100**
Distribution of Pupils' Mathematics Anxiety		
Mathematics Anxiety	**Frequency**	**Percentage (%)**
High	37	62
Low	23	38
Total	**60**	**100**

Table 4.1 shows gender distribution of pupils with mathematics disability. The analysis revealed that 26 pupils, representing 43% of the pupils who participated in the study were males and 34 pupils representing 57% of the participants were female. This implies that, more female pupils than male pupils were identified with mathematics disability which accounted for 57% of the sampled participants.

The Table also shows the distribution of pupils with mathematics anxiety. The analysis shows that 37 pupils representing 62% of the participants have high mathematics anxiety while 23 pupils representing 38% of the participants have low mathematics anxiety. This implies that, pupils who have high and low mathematics anxiety were fully represented in this study, which accounted for 62% and 38% of the sampled participants respectively.

4.2 Testing the Null Hypotheses

Ho_1: There is no significant main effect of treatment – guided discovery and model lead test strategies on quantitative reasoning skills of pupils with mathematics disability.

Table 4.2: Analysis of Covariance (ANCOVA) of effect of treatment on Quantitative Reasoning Skills

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	9473.545[a]	12	789.462	9.036	.000	.698
Intercept	2434.021	1	2434.021	27.861	.000	.372
Pretest	3546.698	1	3546.698	40.597	.000	.463
TREATMENT	3087.640	2	1543.820	17.671	.000*	.429
Gender	.606	1	.606	9.340	.002*	.000
Anxiety	6.292	1	6.292	7.972	.000*	.002
TREATMENT * Gender	98.991	2	49.495	.567	.571	.024
TREATMENT * Anxiety	31.433	2	15.717	8.836	.002*	.008
Gender * Anxiety	64.379	1	64.379	.737	.395	.015
TREATMENT * Gender * Anxiety	129.941	2	64.970	.744	.481	.031
Error	4106.105	47	87.364			
Total	118665.000	60				
Corrected Total	13579.650	59				

a. R Squared = .698 (Adjusted R Squared = .620)

It is shown in Table 4.2 that treatment significantly affects the quantitative reasoning skills of pupils with mathematics disabilities $F_{(2,47)} = 17.671$, $P<0.05$; $\eta 2=0.429$). Therefore, hypothesis one is rejected. Therefore, pupils with mathematics disabilities benefit significantly from treatment in terms of quantitative reasoning skills. Guided discovery and model-lead-test strategies are mainly responsible for the high performance of pupils in quantitative reasoning skills. However, the treatment enhanced pupils' quantitative reasoning skills at varying levels. To determine which of the three strategies enhanced pupils, quantitative reasoning the most, the mean score of participants across the various groups is presented in table 4.2.1

Table 4.2.1: Estimated Marginal Means Score of the Quantitative Reasoning Skills Across Groups

Variables	Mean	Std. Error
INTERCEPT		
Pre-test score Quantitative Reasoning Skills	15.17	-
Post-test score Quantitative Reasoning Skills	41.85	1.959
TREATMENT		
Guided-discovery Strategy group	49.86	2.217
Model-Lead-Test Strategy group	44.41	2.294
Control group	32.05	2.155

Table 4.2.1 shows the different mean scores of pupils that were exposed to treatment in the three groups. From the table it is clear that pupils with mathematics disability who were exposed to Guided-discovery strategy have the highest quantitative reasoning skills mean score (49.86), followed by pupils with mathematics disability exposed to model-lead-test strategy (44.41) while pupils with mathematics disability in the control group have the lowest quantitative reasoning skills mean score (32.05). The performances across the groups are therefore presented in bar chart in figure 4.1

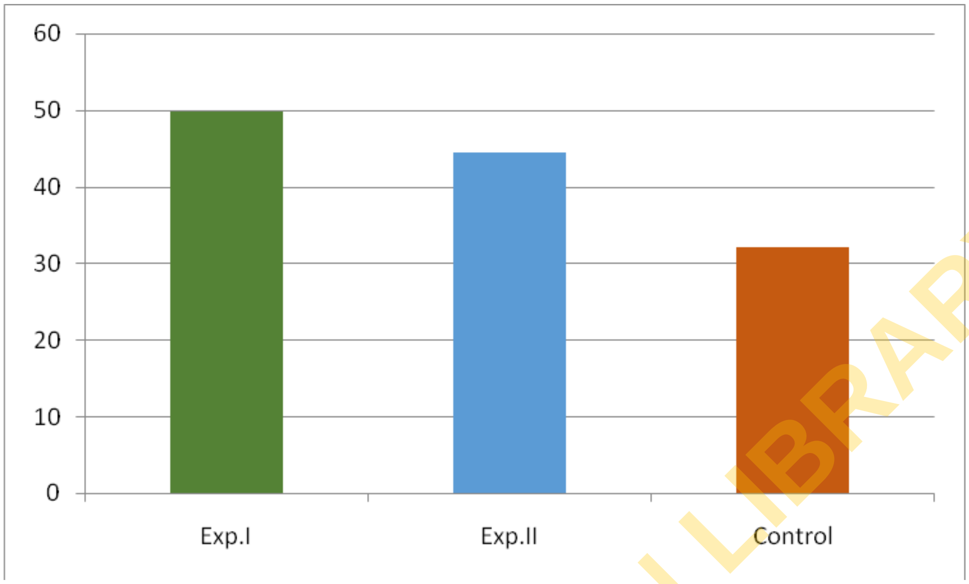

Figure 4.1: Bar Chart on Quantitative Reasoning Skills Scores across the Groups

In order to know the source of the significance as revealed by table 4.2, Scheffe' pairwise comparison was conducted, and the summary is presented in table 4.2.2.

Table 4.2.2: Scheffe' Post Hoc Pairwise Comparison on Quantitative Reasoning Skills

Treatment	Treatment groups	Mean difference	Std error	Sig
Guided-discovery Strategy	Model-lead-test strategy	17.810	3.072	.000*
	Control	5.447	3.201	.286
Model-lead-test Strategy	Guided discovery strategy	12.362	3.165	.001*
	Control	-5.447	3.201	.286
Control Group	Guided discovery strategy	-17.810	3.072	.000*
	Model-lead-test strategy	-12.362	3.165	.001*

Note: * indicates significant differences

Table 4.2.2 shows that the significant main effect that was stated in table 4.3 was so because of the significant difference between:

i. Guided-discovery strategy and Model-lead-test strategy

ii. Guided discovery strategy and control

iii. Model-lead-test strategy and control

Hence, Guided-discovery improved pupils' quantitative reasoning skills significantly more than the model-lead-test. In contrast, the model-lead-test strategy was significantly better than the conventional strategy.

Ho2: There is no significant main effect of gender on quantitative reasoning skills of pupils with mathematics disability.

Table 4.2 shows that there is significant main effect of gender on quantitative reasoning skills of pupils with mathematics disability ($F_{(2,47)}$=9.340; $P<0.05$; η^2=0.000). Therefore, hypothesis two is not accepted. Thus, the quantitative reasoning skills of pupils with mathematics disabilities are significantly influenced by gender. In order to show the actual significance based on gender, the estimated marginal mean was computed as shown in table 4.2.3.

Table 4.2.3: Estimated marginal mean of main of gender on quantitative reasoning skills

Treatment groups	Gender	Mean X	Std. Error
Treatment group 1 (GDS)	Male	49.82	2.29
	female	41.41	2.01
Treatment group 2 (MLT)	Male	44.40	2.22
	Female	32.10	2.15
Treatment group 3 (Control)	Male	14.19	1.96
	Female	12.40	3.16

Table 4.2.3 shows the mean score of male and female pupils in quantitative reasoning skills across groups. It is revealed that in treatment group 1 male pupils scored higher with a mean score of 49.82 followed by male pupils in group 2 with a mean score of 44.40 and lastly the males in the control group score had the mean score of 14.19. It is obvious therefore, that male pupils scored significantly better than the female pupils across the three groups. The implication, therefore, is that gender has significant main effect on quantitative reasoning skills of pupils with mathematics disability.

Ho3: There is no significant main effect of mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

Table 4.2 shows that there is a significant main effect of mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability ($F_{(2,47)}$=7.972; P<0.05; η^2=0.002). Therefore, hypothesis three is not accepted. Hence it implies that there is a significant main effect of mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability. In order to show the main significance-based mathematics anxiety, the estimated marginal mean was computed as shown on the table 4.2.4.

Table 4.2.4: Estimated marginal mean for main effect of mathematics anxiety on quantitative reasoning

Treatment groups	Mathematics anxiety	Mean X	Std. Error
Treatment group 1	High	35.40	2.23
	Low	54.71	3.20
Treatment group 2	High	35.70	2.25
	Low	47.06	3.34
Treatment group 3	High	13.52	1.98
	Low	17.10	2.42

Table 4.2.4 revealed that pupils with low mathematics anxiety scored higher than those with high mathematics anxiety across the groups. In the treatment group one, pupils with low mathematic anxiety obtained a mean score of 54.71 while those with high mathematics anxiety scored 35.40. In group two pupils with low mathematics had a mean score of 47.06 while those with high mathematics anxiety scored 35.70 followed by pupils in group three, pupils with low anxiety had a mean scored of 17.10 and those with high anxiety scored a mean of 13.52. This implies that there is a significant main effect of mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability. Therefore, the lower the mathematics anxiety, the higher the score in quantitative reasoning whereas the higher the mathematics anxiety the lower the score in quantitative reasoning.

Ho_4: There is no significant interaction effect of treatment and gender on quantitative reasoning skills of pupils with mathematics disability.

The results in Table 4.2 show that treatments and gender have no significant interaction effect on the quantitative reasoning skills of pupils with mathematics disabilities $F_{(2,47)} = 0.567$; $P>0.05$; $\eta 2=0.024$. It is, therefore, appropriate to reject hypothesis four. The implication, therefore, is that there is no two-way interaction of treatment and gender on the quantitative reasoning skills of pupils with mathematics disabilities. The quantitative reasoning skills of pupils with mathematics disabilities are not affected by the interaction between treatment and gender.

Ho_5: There is no significant interaction effect of treatment and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability

The results of Table 4.2 indicate that mathematics anxiety and treatment have a significant interaction effect on the quantitative reasoning skills of pupils with mathematics disabilities ($F_{(2,47)} = 8.836$; $P>0.05$; $\eta 2=0.008$). Therefore, hypothesis five is not accepted. The implication of this is that there is a two-way interaction effect of treatment and mathematics anxiety on quantitative reasoning skills. Thus, pupils with mathematics disabilities are significantly affected by both treatment and mathematics anxiety. The study revealed that pupils exposed to the model-lead-test strategy demonstrated superior performance to participants in the control group.

Ho6: There is no significant interaction effect of gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

Based on Table 4.2, gender and mathematics anxiety do not have a significant interaction effect on the quantitative reasoning skills of pupils with mathematics disabilities ($F_{(1,47)}$ = 0.737; P>0.05; ɳ2=0.015). Therefore, null hypothesis six is not accepted. Therefore, gender and mathematics anxiety does not have a two-way effect on acquiring quantitative reasoning skills among pupils with mathematics disabilities.

Ho7: There is no significant interaction effect of treatment, gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

Based on Table 4.2, pupils with mathematics disabilities do not exhibit significant interactions between treatment, gender, and mathematics anxiety ($F_{(2,47)}$ = 0.74; P>0.05; ɳ2=0.03). Therefore, hypothesis 7 is accepted. It, therefore, implies that treatment, gender and mathematics anxiety do not have a combined effect on pupils' achievement in quantitative reasoning skills. As a result, pupils with mathematics disabilities does not exhibit significant interaction effects between treatment, gender, and mathematics anxiety.

4.3 Discussion of Finding

The discussion of the findings of this study is based on the hypotheses tested at 0.05, level of significance in this study. The hypothesis-by-hypothesis discussion is as follows:

4.3.1 Main effect of treatment – guided discovery and model lead test on quantitative reasoning skills of pupils with mathematics disability

The result of null hypothesis one, stating that treatment does not significantly affect pupils with mathematics disabilities' quantitative reasoning skills, shows that hypothesis to be rejected. Hence the alternate hypothesis is accepted, meaning that there is a significant main effect of treatment–guided discovery and model-lead-test on the quantitative reasoning skills of pupils with mathematics disabilities. The study showed that guided discovery and model lead test strategies improved quantitative reasoning skills acquisition of pupils with mathematics disabilities. The study further revealed that the guided discovery strategy is more effective in improving mathematics disability than the mode-lead test strategy. In contrast, the model-led strategy is more effective than the conventional strategy.

Therefore, this study's finding indicates that the guided discovery strategy improved the quantitative reasoning skills of pupils with Mathematics disabilities better than the model lead–test strategy. Compared to the conventional (control) strategy, the model lead test strategy performed significantly better. Therefore, it is concluded that treatment significantly affects the quantitative reasoning skills of pupils with mathematics disabilities. The result indicates that the two experimental groups differed statistically significantly in their achievement scores in quantitative reasoning skills due to the treatment (guided discovery and model-lead-test) in enhancing pupils' performance. As a result, this finding is consistent with Klahir and Nigam's (2014) finding that learners can discover new relationships about learning domains only if they are guided carefully and gradually in their learning process. Any instructional strategy clouded with ambiguity makes the learning experience rather frustrating and stressful for students, especially students with disability.

An excellent instructional strategy is a veritable tool with which the teacher in the classroom enhances pupils learning and, ultimately, high performance. When such strategies are employed in teaching complex concepts like quantitative reasoning, pupils' fears are alleviated, making room for pupils' participation and understanding of the concept. This finding is also in line with Hott, Isbell and Montani (2014), who observed that in the absence of intensive instructional intervention, students with mathematics disabilities lag significantly behind their peers. The guided discovery strategy is a robust instructional intervention for pupils who exhibit mathematics disability because the strategy provides the much need guidance that the pupils require to cope or meet the challenges of learning mathematical computation.

This finding also corroborated Owen (2013) that a guided discovery strategy allows students to use different steps to analyse and solve mathematical problems. When pupils are equipped with the approach to solving problems, it enables them to discover answers, principles, rules and quantities for themselves. Hence, guided discovery strategy provides such step-by-step procedure thereby significantly improving the performance of primary school pupils in quantitative reasoning. School pupils need to be guided by the teacher when solving problems on quantitative reasoning. The finding of this study also agreed with the findings of Monsston and Aslawarth (2012) that when pupils are guided, they can develop the skills needed to enquire, compare quantities, invent, discover, reflect and draw valid conclusion pertaining to a particular area of mathematics concept.

Quantitative reasoning skills is the most needed skill for everyday life could be impacted to a large extent in primary school pupils through the guided discovery strategy. Quantitative reasoning skills help pupils to become independent, teachers therefore need to select appropriate instructional strategy to help pupils become independent, strategic, and motivated learners. This is supported by Alberta (2012) who asserted that when guided discovery strategy is effectively used students are bound to accomplish task and meet learning goals. This is possible with pupils with mathematics disabilities in primary school for the following reasons: It motivates pupils and help them focus attention, organize information for understanding, discover and remembering and monitor. The finding of this study is not in agreement with Campbell, Farrows and Riley (2016) who found that through guided discover strategy independent problem solving will more likely lead the learners to remember aspects of quantitative reasoning.

The result revealed that the model lead test is another explicit instructional strategy that enhances the quantitative reasoning skills of primary school pupils.The pupils' quantitative reasoning skills significantly improved as they were exposed to model lead-test strategy. The study revealed that pupils exposed to the model-lead-test strategy demonstrated superior performance to participants in the control group. This finding corroborated the findings of Dennen (2014) who found that through modeling the pupil's limitation and demonstration of temporal process of thinking is enhanced. It therefore means that with increased temporal process of thinking learners can participate and learn quantitative reasoning with maximum skills for high academic performance. Model-lead-test (MLT) strategy does not only enhance thinking it give the learner a leverage to organize, plan, analyse quantities for everyday survival within the society.

Quantitative reasoning has to do with real-life problem-solving skills. For learners to be equipped with such skills, they need to be grounded in quantitative reasoning. This study revealed that model lead test strategy is an effective strategy in teaching quantitative reasoning to learners with mathematics disabilities. This finding is consistent with Karen (2013) who observed that using model lead test strategy to teach quantitative reasoning is particularly motivating for learners with disability in mathematics. In this way pupils are given a valuable gift of learning to learn instead of depending on the teacher for learning. It is essential therefore to recreate the classroom instruction as a modeling lesson, where the use of visual or examples are relevant, pupils' model as they think out loud so that they can hear the process and present logical model of problem solving.

4.3.2 Main effect of gender on quantitative reasoning skills of pupils with mathematics disability

The result of hypothesis two indicated that there is a significant main effect of gender on quantitative reasoning skills of pupils with mathematics disabilities. The study revealed that male pupils performed better than female pupils in quantitative reasoning. This difference is seen in the analysis in table which indicated that the mean score of male in the three groups are significantly different with male in group 1 scoring 49.82 followed by male in group 2 scoring 44.40 and males in group 3 scoring the least 15.19, whereas the females in the three groups had the mean score of 41.41, 32.10 and 12.40 respectively. There is therefore significant difference in the mean score of the male and female pupils in quantitative reasoning which invariantly indicates that such performance transcends mathematics also.

The finding of this study is in line with the finding of Badmus (2016) which revealed that boys are better in mathematics than girls. It can then be concluded that boy are more confident in tackling mathematics problems than the girls. Gender therefore has shown a main effect on the quantitative reasoning skills of pupils with mathematics disabilities. Achievement disparity of male and female pupils with mathematics disability may be engendered by the societal stereotype that seem to assign certain role to either of the sexes, which reflects during study chosen by the pupils once they enter school. This finding corroborated the finding of David (2011) that socio cultural barriers are more pronounced when it comes to scientific, technological, and vocational education and unfortunately tragic when it covers mathematics education and the girl child.

This study reveals that gender is a major factor that affects performance in quantitative reasoning skills. Although all the participants in this study were pupils with mathematics disability but with proper and adequate instructional strategies pupils performance in quantitative reasoning can improve significantly. Be that as it may, the male pupils tend to have a positive disposition toward quantitative reasoning while the females tend to have some misconceived ideas that make them display negative attitude toward the subject. Consequently, those with positive attitudes outperform these with negative attitude. This is in consonance with Gaidsman (2015) who found that female students show negative attitude toward the study of mathematics and, the use of technology and that such attitudes account largely for the poor performance of female students in mathematics.

Quantitative reasoning may not be a male subject, but the male pupils seem to be more positively disposed toward the study of quantitative reasoning in school. This is probably the reason why most field of study that are mathematically inclined are dominated by the male folks. Pupils with mathematics disability generally exhibit poor number sense. Understanding the concept of number can help the pupils to pull together fragmented pieces of information through quantitative reasoning skill to improve upon their mathematics achievement. This is indeed the factor underlying the difference in the performance of male and female pupils in quantitative reason skills. This finding corroborates Gersten and Chard (2017) that mathematical reasoning in children is characterized with three major problems: namely, high frequency procedural errors. Secondly difficulty in representation and retrieval of mathematical facts and the third is inability to symbolically or visually represent or code numerical, information for storage in the brain. Girls were found to be apt in using words as unit or form for storage in the brain in contrast with the boys who are prone to using symbolic, numerical context as unit of storage. This makes a huge difference in their performance in quantitative reasoning.

4.3.3 Main effect of mathematics anxiety on quantitative reasoning of pupils with mathematics disability

Hypothesis three which stated that there is no significant main effect of mathematics anxiety on quantitative reasoning skills of pupil with mathematics disability is rejected. It therefore implies that there is significant main effect of mathematics anxiety on quantitative reasoning skills. Pupils with high mathematics anxiety perform poorly in quantitative reasoning skills while these with low mathematics anxiety perform better in quantitative reasoning. This finding agrees with the finding of Wang, Hart, Kovas, Lukowski, Soden and Thompson (2014) that children with high mathematics anxiety are significantly slower and less accurate on mathematics problem than those with low mathematics anxiety. When pupils experience high mathematics anxiety their quantitative reasoning skills drop as they could fail even what they ordinarily would pass. Mathematics anxiety cast a shadow of “I cannot do it” on the pupils such that they easily lose confidence and give up trying.

This finding supports Jameson and Ross (2011) who found that primary school students who experience high mathematics anxiety have more negative attitudes towards mathematics consequently they score lower than pupils with low mathematics anxiety. High anxiety results in computation anxiety. As a result, the pupil tends to dislike any subject or course of study that entails computation. Therefore, when presented with quantitative reason the adverse negative effect of mathematics anxiety quickly becomes obvious in their poor performance. This is supported by Okafor and Anaduka (2013) stating that students with high mathematics anxiety suffer how self efficacy in mathematics and consequently perform poorly in quantitative reasoning. At the long run pupils with mathematics anxiety may suffer low self-esteem. Phobia may be normal for school age children, but anxiety can really be disturbing for pupils with mathematics disability especially when the anxiety is triggered by mathematics, it can become extreme such that its hinders good performance in quantitative reasoning and other day to day life activities.

Mathematics anxiety inhibits clear thinking, which is a prerequisite for quantitative reasoning skills, therefore where clear thinking is inhibited quantitative reasoning skills diminish. Shore (2013) agreed with this by stating that the brains of children with mathematics anxiety seem to shutdown as soon as they detect mathematics problems. This may be the reason why pupils with mathematics disability experience high mathematics anxiety try to avoid classes where they would be presented with mathematics problems so that they don't look stupid before their classmates. Pupils with mathematics disability fall into the pit of anxiety easily when adults and significant others around them give negative impression and express utter dislike for mathematics. When pupils are made to believe that they cannot do well in the subject like others who have tried before them, anxiety naturally well up in their heart, fear and avoidance of mathematics and mathematics related subject takes it full course.

4.3.4 Interaction effect of treatment and gender on quantitative reasoning skills of pupils with mathematics disability

The finding of this study indicates that the quantitative reasoning skills of pupils with mathematics disability did not differ significantly irrespective of the fact that they are males or females. This finding is in consonance with Lenard (2012) and Switzer (2014) who observed that both boys and girls can do equally well in quantitative reasoning skills provided a good instructional strategy is in place. It implies that being a male is no added advantage in quantitative reasoning skills just as being a female is no disadvantage in quantitative reasoning skills. Both male and female pupils stand a chance to perform equally well as they both have the capacity to learning quantitative reasoning their gender notwithstanding.

The finding of this study further reveals that the treatment guided discovery strategy and model lead test do not benefit pupils on the basis of their gender. Both males and females stand to benefit from quantitative reasoning instruction inasmuch as they are exposed to same and equal learning opportunity. The finding of this study reveals that gender is not a factor of interference with treatment that affects pupils quantitative reasoning skills. This finding supports the assertion of Hill, Devine and Szucs (2016) that girls' and boys' performance on mathematics test was the same, even though mathematics particularly and science generally are male dominated.

4.3.5 Interaction effect of treatment and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability

This null hypothesis was rejected based on the result of the study which showed a significant interaction effect of treatment and mathematics anxiety on quantitative reasoning skills. The finding of this study therefore reveals that there is a two-way interaction effect of guided discovery, model lead test strategies and mathematics anxiety on pupils' quantitative reasoning skills. This finding corroborates the assertion of Mosston (2016) that instructional strategy that engages students within operations and classroom function drawing its operation from real life situations and application clarifies student's anxiety and improve performance.

Guided discovery and model lead test strategies have been found in this study to be pupils friendly, pupil centered, developing in pupils a logical, sequential thinking which build pupils confidence thereby reducing mathematics anxiety. As mathematics anxiety reduces pupils quantitative reasoning skills performance increases. This finding supports the finding of Dahi, Mchanghlin, Belcher and Weber (2013) that direct instruction like model lead test provides a great deal of opportunity for pupils to practice the skills being taught thereby reducing anxiety and increasing skill performance. High mathematics anxiety leads to poor performance while low mathematics anxiety combined with direct instruction enhance good performance in quantitative reasoning skills. The treatments – model lead test operates at four levels to enable pupils to overcome their anxiety for number fact: Model lead test uses (i) "I do it, we do it, and you do it" as the teacher demonstrates the facts (ii) the teacher and pupils work together to perform the skill (iii) the demonstrated task is repeated and (iv) the pupils do the skill by themselves. This process helps to develop confidence and reduce mathematics anxiety allowing the pupils the master quantitative reasoning skills.

4.2.6 Interaction effect of gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability

The finding reveals no significant interaction between gender and mathematics in enhancing or inhibiting quantitative reasoning of primary school pupils. This finding negates the assertions of Ojo (2004) and Omobanjo (2008) which attributed the difference in the performance of boys and girls in mathematics to the fact that girls experience high mathematic anxiety than boys. The contradiction between this present finding and that of Ojo (2004) and Omobanjo (2008) may be because this present study examines strictly, the quantitative reasoning skills of primary school pupils while Ojo and Omobanjo examine performance in general mathematics. Suffice it therefore to say that quantitative reasoning skills of primary pupils and their mathematics anxiety, where pupils are exposed to adequate instructional strategy their quantitative reasoning skills would improve significantly, their gender and mathematics anxiety notwithstanding.

This finding corroborates the findings of Hill, Devine and Szucs (2016) who found that even though mathematics and science are stereotyped male domains, both male and female students performed equally well on mathematics test. This finding is also in variance with Carey, Hill and Devine (2016) who found consistent differences in developmental dyscalculia and mathematics anxiety of primary school pupils. However, the finding is consistent with Yeo, Tan and Lew (2015) who found no relationship between gender and mathematics anxiety. Pupils develop anxiety toward mathematics because they had suffered failure repeatedly in the past. As a result they tend to avoid mathematics this invariably affect their quantitative reasoning skills. This finding is supported by three other studies Ozgur (2014), Pourmoslemi, Erfani, Firoozfar (2013) and Zakaria, Zain, Ahmad and Erlina (2012) all found no significant relationship between mathematics anxiety and gender.

4.3.7 Interaction effect of treatment, gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability

Based on the result of that study, the null hypothesis seven is accepted. This study reveals that each of these variables – treatments, gender and mathematics anxiety operates independently to enhance pupils' quantitative reasoning skills. The finding of this study supports the assertion of Chen (2014) that model lead test strategy increase students' performance but found not relationship with oral lecture discussion and other moderator variables. Similarly, Switzer (2014) and Cakin (2018) affirmed that good instructional strategy that is properly implemented is not about helping pupils to accumulate knowledge that is hand down to them by the teacher, rather it is about helping pupils make sense of new information, to integrate new information with existing idea and applying them to meaningful real-life situation. The finding of this study, however, contradicts Bosch and Trigueros (2016) who opined that other factors interplay with classroom instruction to either enhance or inhibit knowledge acquisition and utilization.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of the findings of the study. Based on the hypotheses generated and tested in this study this chapter is organized under the following headings: Summary of findings, conclusion and recommendations. Educational implications are also drawn from the findings of the study contributions to knowledge, limitation of the study and suggestions for further studies were also made.

5.1 Summary

This study investigated the effect of guided discovery and model lead test strategies on quantitative reasoning skills of pupils with mathematics disability in Uyo, Akwa Ibom State. A quasi-experimental design was adopted for the study, which consisted of pretests and posttests. This research design was appropriate because it allowed the researcher to ascertain the effect of the independent variables on the dependent variable. The study also examined the effect of two moderator variables – gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

The sample size of this study comprised 60 primary five pupils with mathematics disability. The sample was drawn through multi-stage random sampling technique and screening process using standardized instruments. The multi – stage sampling technique involved: stage 1, three Local Government Areas were randomly drawn from the existing nine Local government areas. Stage 2, one school was randomly drawn from each of the three Local Government Areas earlier selected. Stage 3, in each of the three schools, teachers nominated pupils suspected to have mathematics learning disability. Stage 4, all teacher nominated pupils were thoroughly screened for learning disabilities, mathematics disability, quantitative reasoning skills deficit and mathematics anxiety using Pupils' Rating Scale, Kaufman Test of Educational Achievement 2nd edition, quantitative reasoning deficit scale and mathematics Anxiety Scale respective. Finally 20 pupils with mathematics disability were selected randomly from each of the three schools, giving a total of 60 pupils who participated in the study.

Participants were grouped into three groups, comprising two experimental and control groups. Guided discovery and model lead test strategies were used as intervention for each of the experimental group while the conventional method was used with the control group. Data were collected through administration of pretest and posttest using the Quantitative reasoning achievement test (QRAT). At a significance level of 0.05, the collected data were subjected to statistical analysis of covariance (ANCOVA). Scheffe postHoc test was used to isolate the main effect and source of significance of each variable.

The study's result showed that guided discovery and model lead test strategies significantly affected the quantitative reasoning skills of pupils with mathematics disabilities. The study however showed that the guided discovery strategy is more effective in enhancing quantitative reasoning skills than the model lead test strategy. Recommendations and suggestions for further studies were made based on the findings.

5.1.1 Summary of Findings

1. There is significant main effect of treatment on quantitative reasoning skills of pupils with mathematics disability. Guided-discovery strategy improved quantitative reasoning skills of pupils with mathematics disability significantly better than the model-lead-test strategy, while model-lead-test strategy was significantly better than conventional strategy.
2. The quantitative reasoning skills of pupils with mathematics disabilities differ significantly by gender.
3. There is significant main effect of mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.
4. The quantitative reasoning skills of pupils with mathematics disabilities are not significantly affected by treatments or gender.
5. The interaction between treatments and mathematics anxiety significantly impacts the quantitative reasoning skills of pupils with mathematics disabilities.

6. There is no significant interaction effect of gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

7. There is no significant interaction effect of treatment, gender and mathematics anxiety on quantitative reasoning skills of pupils with mathematics disability.

5.2 Implications of the Study

This study has significant implications, which cannot be overstated. The findings of this study have a lot of implications for pupils with mathematics disability, teachers of pupils with mathematics disability, special educators, regular classroom teachers, parents, educational policy makers, curriculum planners and school administrators. The implications of this study are as follows:

That research based instructional strategies such as guided discovery and model lead test strategies are veritable strategies for meeting academic needs of primary school pupils with mathematics disability. Guided discovery and model lead test strategies make the teaching and learning of quantitative reasoning interesting and successful for pupils alone with mathematics disability. Pupils with mathematics disability can perform well in quantitative reasoning when exposed to guided discovery and model lead test strategies. Quantitative reasoning skills is not the reserve of male pupils as both males and females exposed to good instructional strategies like guided discovery strategies can actually improve their quantitative reasoning skills significantly.

Mathematics anxiety has significant effect on quantitative reasoning skills of primary school pupils but with effective teaching strategies such as guided discovery and model-lead-test mathematics anxiety can the reduced drastically to allow for improved quantitative reasoning skills. Learners with low mathematics anxiety have the capacity to perform better in quantitative reasoning than those with high mathematics anxiety. Each variables in this study (treatment, gender and mathematics anxiety operate independently in enhancing pupils quantitative reasoning skills. From this study, there is no reason for pupils with mathematics disability to be left behind by teachers during quantitative reasoning classes. Pupils with mathematics disability themselves through the findings of this study would be adequately guided to learn and enjoy learning quantitative reasoning as a subject in school.

5.3 Limitations of the Study

While carrying out this study, the researcher encountered certain limitations that militated against the study. Some of the limitations include, dearth of indigenous literature, research materials on quantitative reasoning at the primary school level. During this study the research realized that limited research done on quantitative reasoning skills. More so, available studies have focused more on quantitative reasoning skills of individuals without disabilities, with just a few investigating pupils with mathematics disability. This study is also limited by time factor.

The time spent on the field was eight weeks. If more time was spent with the pupils considering their disability, the result of this study may have been a bit better. Financial constraint is another limitation this study encountered. Most of the materials needed for the study were not readily available in the schools, so were simply improvised as the researcher could not afford the cast of purchasing them.

5.4 Conclusion

This study investigated the effect of guided discovery and model-lead-test strategies on quantitative reasoning skills of pupils with mathematics disabilities in Uyo Akwa Ibom State. Two moderator variables were examined in the study which are, gender and mathematics anxiety. The findings of the study have shown clearly that the two treatments were effective in enhancing quantitative reasoning skills of pupils with mathematics anxiety disability. The study indicated that guided discovery strategy improved pupils' quantitative reasoning skills better than the model lead test strategy. However, the model lead test strategy was more effective than the conventional approach in enhancing pupils' quantitative reasoning skills. Considering the findings of the study suffice it to say that when teacher use guided discovery and model lead test strategies over time to teach pupils with mathematics disabilities, the pupils would become more and more interested in, enjoy and perform better in quantitative reasoning skills, their gender and mathematics anxiety notwithstanding.

5.5 Recommendations

The following recommendations are made based on the findings of this study. Teachers should adopt guided discovery model lead test strategies as mode of teaching quantitative reasoning to pupils with mathematics disabilities. Head teachers of schools should endeavour to encourage their teachers to use these proven strategies consistently over time in order to effectively enhance quantitative reasoning skills of their pupils.

Professional bodies should from time to time organize workshops, seminars and conferences for primary school teachers where teachers can learn to use guided discovery and model lead test strategies in every classroom in the interest of pupils with disabilities. Curriculum planners should endeavour to incorporate guided discovery and model lead test strategies into the school curriculum and ensure that teachers apply them to benefit learners. Pupils with mathematics disability should take advantage of these pupils' friendly strategies and attend classes where guided discovery strategies are used so that they can improve upon their quantitative reasoning skills.

Teachers should endeavour to adequately motivate both male and female pupils to participate in quantitative reasoning lessons or activities, be it in the classroom outside classroom. School administrators should give prizes and awards to best pupils in quantitative reasoning skills at the end of every school term to encourage and make pupils see the importance of quantitative reasoning skills

State universal basic education board (SUBEB) should provide special incentives or award for teachers of pupils with disabilities what implement research based strategies like guided discovery and model lead test strategies to teach pupils. Parents and teachers should collaborate to help pupils overcome mathematics anxiety so that they can learn quantitative reasoning skills adequately.

5.6 Contributions to knowledge

This study has contributed immensely to the body of knowledge. The contributions of this study are as follows: Guided discovery and model lead test strategies have successfully enhanced primary school pupils' quantitative reasoning skills. Although these strategies have been used with pupils on other subjects but this study has particularly shown that these two strategies are useful for teaching quantitative reasoning to pupils with mathematics disability.

Pupils with mathematics disability in public primary schools who have been avoiding quantitative reasoning and mathematics over the years can now enjoy learning quantitative reasoning as a subject. This study has also proved that conventional teaching strategy has not adequately enhanced quantitative reasoning skills of pupils with mathematics disability hence guided discovery and model lead test are adequate in enhancing pupils quantitative reasoning skills.

This study has equally proved that high mathematics anxiety if not checked and quickly remedied can result in poor performance in quantitative reasoning particularly and mathematics generally. Similarly, pupils with low mathematics anxiety can perform better in quantitative reasoning skills. Gender is a factor in teaching and learning of quantitative reasoning skills. Male and female pupils therefore are capable of performing equally well when exposed to, guided discovery and model lead test strategies.

This study has added to the repertoire of teaching strategies available to teachers of pupils with mathematics disability particularly and regular education teachers generally. It has also added to the number and volume of reference materials available to future researchers.

5.7 Suggestions for Further Studies

The following suggestions are made for further research. There is potential for replication of this study in a wider geographic area, such as Akwa Ibom State, South-South or Nigeria. Students with learning disabilities could benefit from guided discovery and model lead tests in secondary and higher education. Further studies could be carried out on improving quantitative reasoning skills of student with other categories of disabilities. Other treatment packages could be explored to enhance quantitative reasoning skills of out of school adults with disabilities to improve their daily living skills

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APPENDIX I

EXCERPT FROM SLOSSON INTELLIGENCE TEST REVISED THIRD EDITION

Begin age ten.

75. WHY SHOULD CHILDREN REMAIN IN SCHOOL UNTIL THEY GRADUATE?

To get an education; many places will not hire you if you do not graduate from high school; to get a better job when you finish; so they can go to college

Must pass all three.

76. a. HOW MANY SECONDS ARE THERE IN ONE MINUTE?

Sixty

b. HOW MANY MINUTES ARE THERE IN ONE HOUR?

Sixty

c. HOW MANY HOURS ARE THERE IN A FULL DAY?

Twenty four

If the examinee responds: Twelve, say: 'No a full day, meaning one whole day including day and night.

77. EIGHT BOYS HAVE FIVE NAIRA EACH. HOW MUCH DO THEY HAVE ALTOGETHER?

Forty (naira)

Must pass both.

78. a. HOW ARE ANIMALS AND PLANTS ALIKE?

Both are alive; both live; both reproduce.

b. HOW ARE ANIMALS AND PLANTS DIFFERENT?

Animals move and plants don't; animals eat plants; animals have bones (lungs, etc.) and plants don't; animals use oxygen and plants don't (use carbon dioxide).

If the examinee responds by giving another likeness, say: 'Yes, that is how they are alike but can you tell me how they are different?'

79. FIFTEEN PACKETS OF BISCUIT ARE DIVIDED AMONG THREE GIRLS. HOW MANY DID EACH RECEIVE?

Five (packets)

Must pass one set.

80. SAY THESE NUMBERS BACKWARDS. FOR EXAMPLE, IF I SAY: 123. YOU WOULD SAY: 321. NOW SAY THESE NUMBERS BACKWARDS WHEN I FINISH SAYING THEM: 8 6 9 4. If failure, say: Say these numbers backwards: 3 1 7 5.

Say the numbers slowly, about one second apart; do not group the numbers in any way.

Must repeat one series backwards

Must pass both.

81. a. HOW IS CLOCK DIFFERENT FROM A CALENDAR?

A clock tells the time of day and a calendar tells the days (of the month, year); one runs (moves) and the other does not; a calendar has more numbers.

b. IN THEIR USE, WHAT IS THE PRINCIPAL WAY A CLOCK AND CALENDAR ARE THE SAME OR ALIKE?

They both tell time; both indicate the passage of time, one in hours and the other in days.

If the examinee responds: Both have numbers, say: "Yes, but what is the principle way in which they are the same or alike?"

The concepts of time must be present for a scorable answer.

If the individual replies by giving another different, say: "Yes, that is how they are different, but can you tell me how they are the same or alike?"

82. WHY IS IT IMPORTANT TO HAVE RESTAURANTS INSPECTED BY THE HEALTH DEPARTMENT?

To be sure they are clean; they do not serve bad (spoiled) food; they do not spread disease; to be sure they don't have any sick employees working for them.

Must pass both.

83. HOW ARE NORTH AND SOUTH ALIKE AND HOW ARE THEY DIFFERENT?

Alike: Directions; sections of the country; points on the compass.

Different: Opposite directions; opposite parts of the country; opposite points on the

Compass; north is up on the map and south is down.

84. WHAT DOES VACANT MEAN? FOR EXAMPLE, IF A HOUSE WERE VACANT, WHAT WOULD IT MEAN?

No one lives there; empty; it is not occupied; a room or house available to rent, since no one is living in it.

APPENDIX II

KAUFMAN TEST OF EDUCATIONAL ACHIEVEMENT SECOND EDITION (SCREENING FOR MATHEMATICS DISABILITIES)

Addition Objective 1

1. 4 + 7 (1 mark)
2. 5 + 1 = (1 mark)

Addition Objective 2

3. 742 + 46 (3 marks)
4. 57 + 41 = (2 marks)

Addition Objective 3: Regrouping

5. 54 +27 (2 marks)
6. 273 +439 (3 marks)

Subtraction Objective 1

7. 7 – 2 = (1 mark)
8. 15 - 6 (1 mark)

Subtraction Objective 2

9. 67 - 23 (2 marks)
10. 476 - 32 (3 marks)

Subtraction Objective 3: Regrouping

11. 92 - 7 (2 marks)
12. 523 - 74 (3 marks)

Multiplication Objective 1

13. 6 x 3 (2 marks)
14. 4 x 2 = (2 marks)
15. 3x3 = (2 marks)

APPENDIX III

Mathematics Anxiety Scale for Children (MASC)

Section A

Class: ____________________

Age: ______________________

School: ____________________

Section B

Please indicate the level of your anxiety in the following situation. Choose only one option in each line.

S/N	Item	Not nervous	A little nervous	Very nervous	Very very nervous
1.	Getting a new mathematics book make me				
2.	Reading and interpreting graphs make me				
3.	Listening to a classmate explain a mathematics problem can make me				
4.	Watching the teacher work on a mathematics problem on the board, gets me				
5.	Walking into a mathematics class I get				
6.	Looking through the pages of a mathematics book makes me				
7.	Starting a new chapter in a mathematics book can make me				
8.	Thinking about mathematics outside of classroom makes me				
9.	Picking up math book to begin working on a homework I become				
10.	Working on a problem such as "if I spend ₦3.89k at the store, how much change would I get from a ₦5.00				
11.	Reading a formula in science				
12.	Listening to the teacher in mathematics class.				
13.	Using the tables in the back of a mathematics book				
14.	Being told how to interpret mathematical statements.				
15.	Being given a homework assignment of many difficult mathematics problems which is due the next day.				
16.	Thinking about a mathematics test one day before the test				
17.	Doing a long division problem				
18.	Taking a quiz in mathematics				
19.	Getting ready to study for mathematics test.				
20.	Being given a mathematics quiz that you were				

	not told about				
21.	Waiting to get a mathematics test returned in which you expect to do well.				
22.	Taking an important test in mathematics class.				

APPENDIX IV

QUANTITATIVE REASONING SKILLS DEFICIT SCALE (QRSDS)

SECTION 1

Personal Data:

Age: ______________________________ Class: _____________________

Date:____

Administered by: ____

Section 2:

Instruction: You are please requested to answer the following questions to the best of your ability. Follow the example and reason out the mathematics section involved and write it down before solving:

Basic operations

E.g. 20 / 400   8 / 64   16 / 356

Now to these, first write down the operation to use

(1) [ ] / 36

(2) 9 / [ ]

(3) [ ] / 144

(4) 15 / [ ]

(5) 19 / [ ]

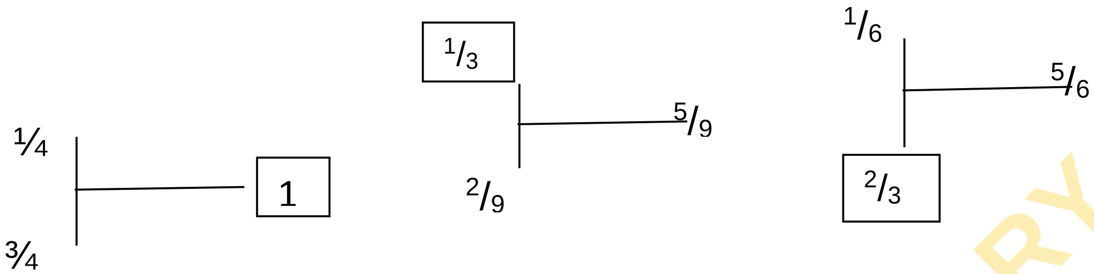
(6) [ ] / 167

(7) 11 / [ ]

(8) [ ] / 100

Score ______

Fractions



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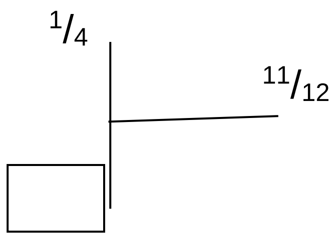

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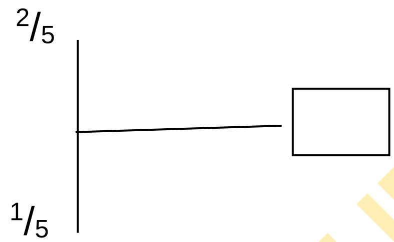

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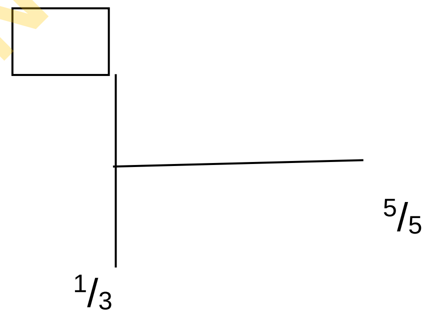

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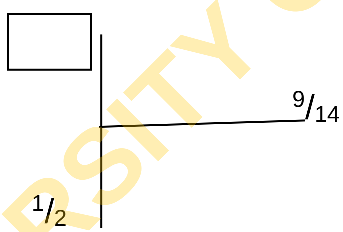

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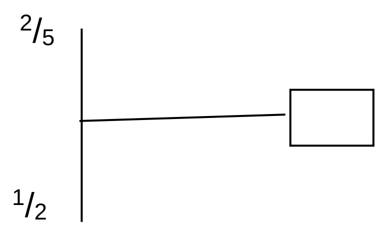

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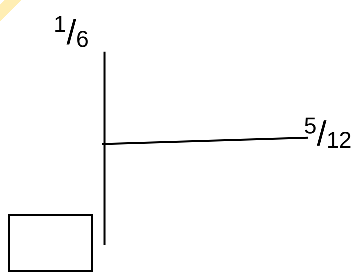

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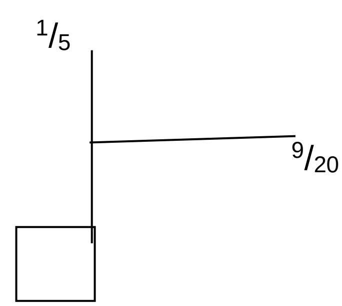

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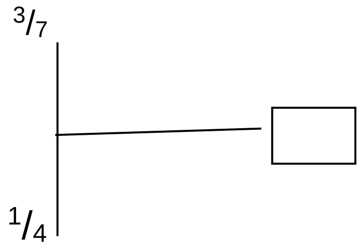

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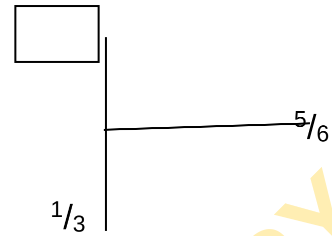
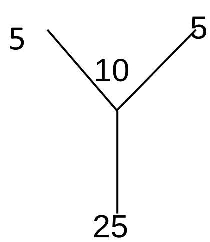
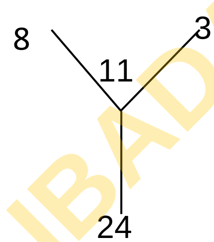


Score:__________

Basic Operations





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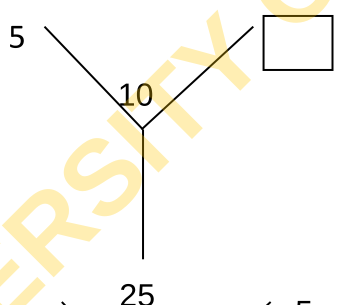

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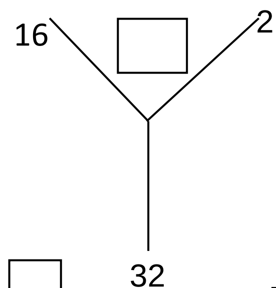

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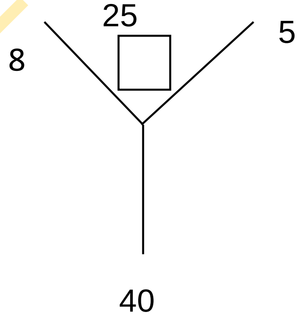

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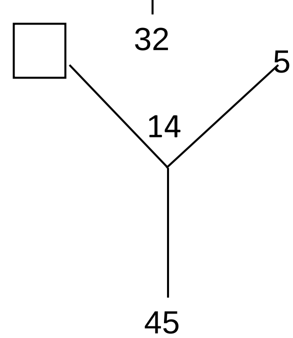

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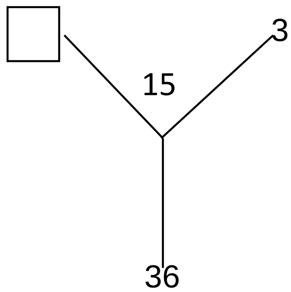

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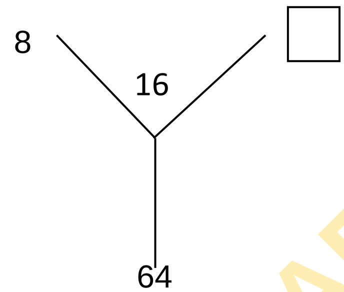

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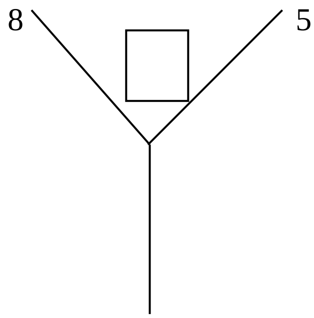

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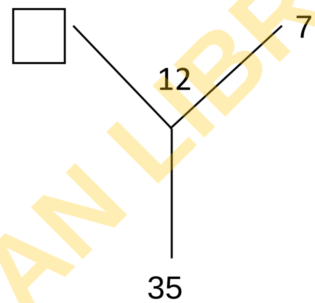


Score: ________________ Total Score: ___________

APPENDIX V

QUANTITATIVE REASONING ACHIEVEMENT TEST (QRAT)

SECTION A

Personal Information:

Class: ______________________________

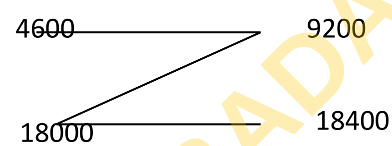
Location: ______________________________

SECTION B

Instruction:

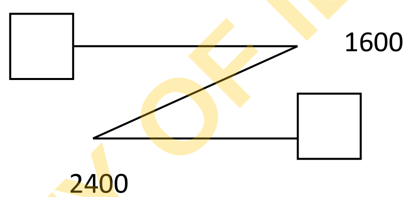
Carefully complete the following:

Example:

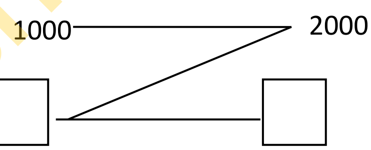


Now answer these:

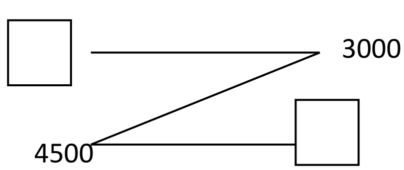
1.



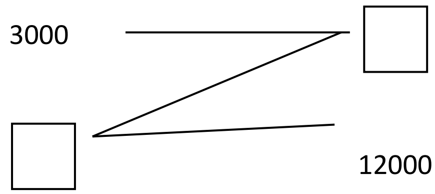
2.



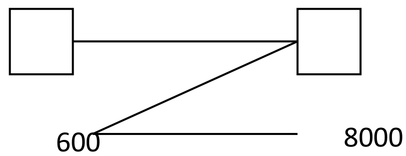
3.



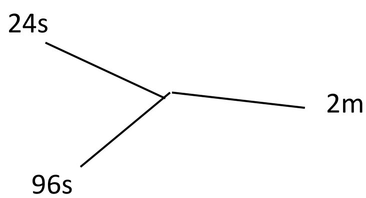
4.



5.

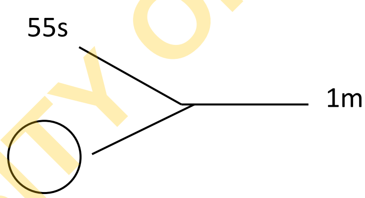


If



What will these be

6.



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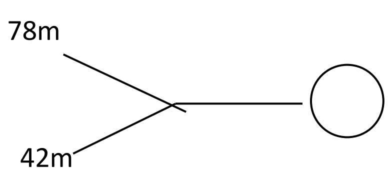

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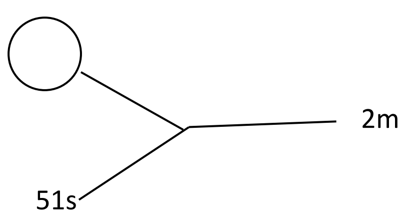

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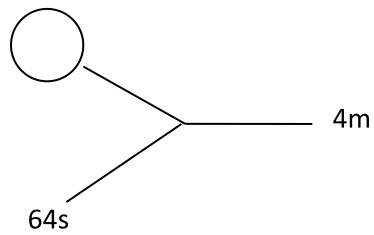

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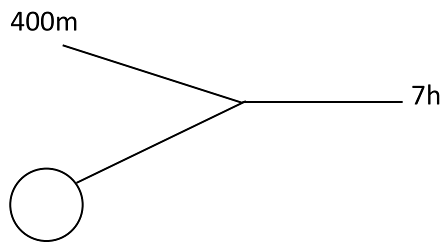


11. $\frac{9}{4}$ ⟷ □

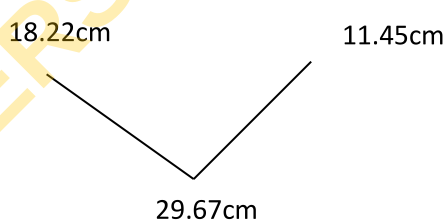
12. □ ⟷ $2\frac{1}{6}$

13. □ ⟷ $4\frac{2}{5}$

14. $\frac{23}{3}$ ⟷ □

15. □ ⟷ $6\frac{3}{7}$

If



Then

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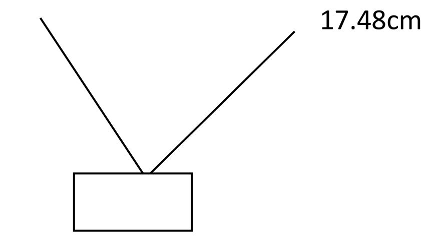

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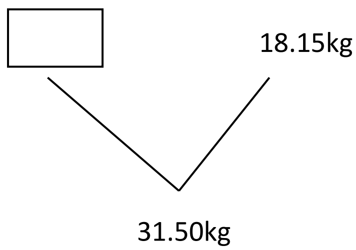

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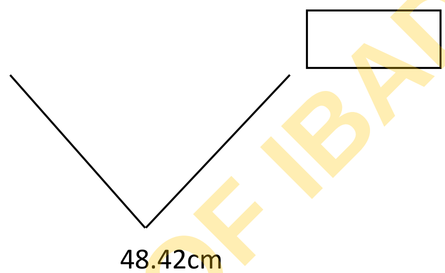

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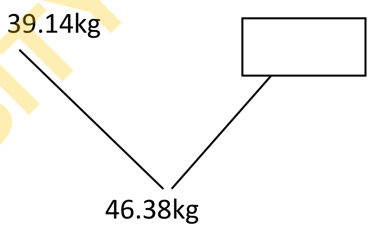

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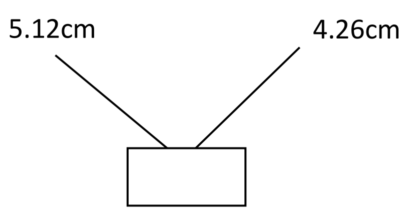
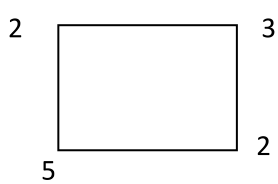


If



Then

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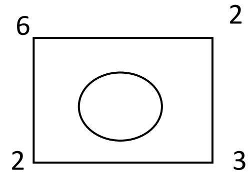

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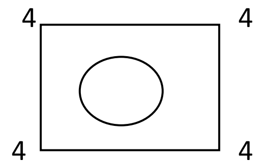

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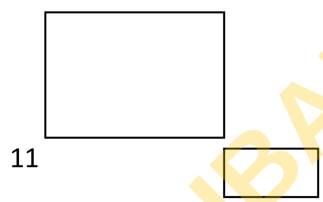

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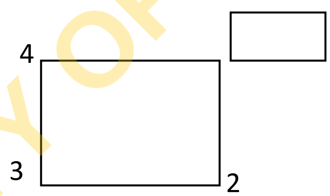

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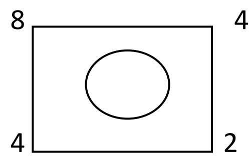


APPENDIX VI

INSTRUCTIONAL PACKAGE: GUIDED DISCOVERY

WEEK 1

Topic: Counting numbers in groups

Class: Primary 5

Time: 40 minutes

Specific objectives: At the end of the less the pupils should be able to:

1. Count a given set of numbers in group
2. Identify the difference among the number in the group
3. Write the missing numbers in the group.

Instructional material: Counters

Previous Knowledge: The pupils already know how to count and write numbers from 1 – 1000.

Presentation

Step 1

The teacher welcomes the pupils to class and tries to make them relax from any form of environmental anxiety. The teacher guide them to sing an action song to make them alert for the lesson

"1, 2, 3, 4, 5
Catching fishes all alive
Why do you let them go?
Because they bite my finger so.
Which finger did they bite?
The little finger on my right"

Step 2

The teacher writes the topic on the board. Ask the pupils to say what they think the topic means. As the pupils say what they think the teachers writes the correct ones on the board. When pupils say an incorrect one, the teacher explains why it is not correct and guides the pupils on how to go about it.

Step 3

The teacher writes the following number series on the board.

a. 15, 20, 25, 30, 35, 40

b. 21, 31, 41, 51, 61, 71

c. 100, 200, 300, 400, 500, 600

Example (a)

The teacher asks the pupils to look at the number in (a) 15, 20, 25, 30, and 40

Then

1. Say the numbers out loud
2. What is the amount of number to add to 15 to get 20 (ans. = 5)
3. What will you add to 35 to get 40 (ans. = 5)

What can you discover here now

Ans.: (i) to get the next number 1 must add 5 to the previous number

(ii) this is counting in 5s

Example 2

b. 21, 31, 41, 51, 61, 71

Solution

The teacher guides the pupils by asking them some leading question to help them discover the right answers.

1. Can you say the numbers in this series aloud?
2. What is the difference between 21 and 31 (31 – 21 = 10)
3. What is the difference between 61 and 71 (71 – 61 = 10)
4. What have you discover here?

Answer: The difference between the numbers is 10. Hence, the numbers are counted in 10s

Example 3

d. 100, 200, 300, 400, 500 and 600

Solution

The teacher guides the pupils to discover the right answers by generating the following questions.

1. What are the numbers in this series (100, 200, 300, 400, 500)
2. What is the difference between the first number and the second?

   200 – 100 = 100
3. What is the difference between the last two numbers

   600 – 500 = 100

4. What have you discovered

Ans: (i) If 1 add 100 to any of the numbers I will get the next number

(ii) The numbers are counted in 100s.

Step 3

The teacher guides the pupils to fill in missing numbers in a given series.

Example 1: 150, _____, 250, _____, ______. 400

Solution:

- What is the first number there? Ans: 150
- What is the next number? Ans: it is missing _____
- After the _____ what number do you have there? Ans: 250
- What is the difference between 150 and 250? Ans: 250-150 = 100
- How many steps will you move from 150 to 250 as in the series? Ans: 2 steps.
- If you divide 100 by 2 what do you have? Ans: 50
- Now try to had 50 to each number and see what you get.
- What have you discovered.

1. Adding 50 to the first number gives the next missing number which is 200. Add 50 to 200 gives the next number 250, adding 50 to 250 gives the next missing number which is 300. The next missing number therefore is 350.
2. The numbers therefore were counted in 50s.

Evaluation: The teacher evaluated the lesson by asking the pupils to do the following

1. Count the numbers in the following group
   a. 60, 70, 80, 90, 100, 110
   b. 160, 165, 170, 175, 180, 185
2. Identify the difference in the group of numbers in a and b above
3. Write the missing numbers in the following group of numbers
   a. 530, 532, 534, _____, 538, ______
   b. 790, _____, 810, 820, ____, _____

Summary

The teacher summaries the lesson by solving the evaluation questions correctly for the pupils and guiding them to think critically on each question by generating some leading question that will guide them to discover answers for themselves.

Home work:

Pupils should go home and do exercise 1 on page 3 of their quantitative reasoning text book.

WEEK 2

Topic: Finding missing numbers

Duration: 40 minutes

Specific objectives: At the end of the lesson the pupils should be able to:

1. Identify the mathematical operation(s) involved
2. Find the missing number

Instructional materials: Counters, addition table and flannel board.

Previous knowledge: The pupils already know how to count numbers and use addition tables.

Presentation

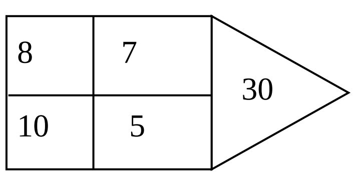
Step 1

The teacher gets the pupils set for the lesson by singing with them an action song that is familiar to the pupils.

"There were 2 black birds
Sitting on the wall
One named Peter, One name Paul
Fly away Peter, fly away Paul
Oh come back Peter, Oh come back Paul
On come back my 2 black birds and sit on the wall?

Step 2

The teacher writes the following examples on the board and ask the pupils to think about it in a few minutes.

1.


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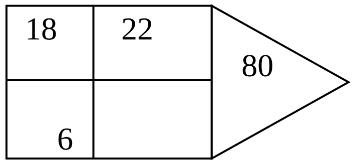

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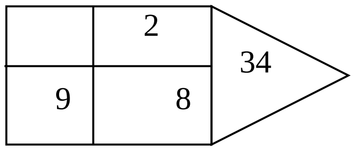
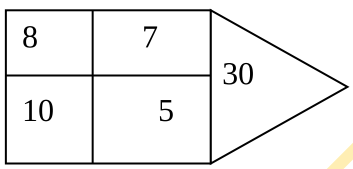


Step 3

The teacher guides the pupils to discover the mathematical operation involved in each of the examples above.

Example 1:



The number in the triangle at the right hand side is normally the answer. To get than what do you do?

The teacher allows the pupils to think that out for themselves. Then begins to guide them thus:

- What mathematical operation do you think is involved here?
- Try adding the numbers in column and in row

That is

8 + 7 = 15

30

10 + 5 = 15

Then

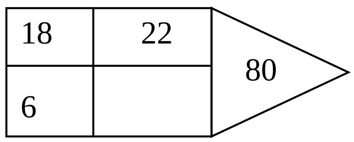
8 + 10 = 18 ⟩ 30

7 + 5 = 12

It means that:

- Mathematical operation is addition (+)
- Both row and column addition give 30 the answer

Example 2



The number in the triangle is the answer (80)

The teacher guides the pupils with the following question:

- What is the operation involved?

Ans: Addition (+)

- How would you get the missing number?

Ans: Add all the numbers in the rectangle

$18 + 22 + 6 = 46$

- What next?

Ans: Form and equation using ‘a’ for the missing number. Thus

$46 + a = 80$

Subtract 46 from both sides of the equality sign

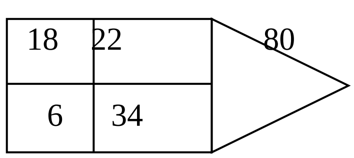
$46 – 46 + a = 80 – 46$

$0 + a = 80 – 46$

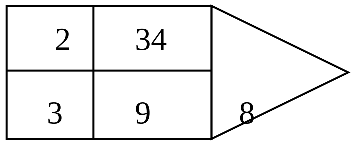
$\therefore a = 80 - 46$

$a = 34$

$\therefore$



Example 3



The teacher guides the pupils to find the missing number
Thus:

- What is the operation involved?

Ans: Addition (+)

- What will you represent the missing number with?

Ans: (x)

- Column addition: x + 2 = x + 2   34
- Row addition: 9 + 8 = 17
- What next?

Ans: Form and equation

x + 2 + 19   = 34

x + 19 = 34

Subtract 19 from both sides

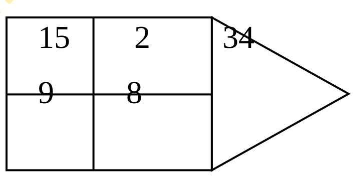
x + 19 – 19 = 34 – 19

x + 0 = 34 – 19

x = 34 - 19

∴ x = 15

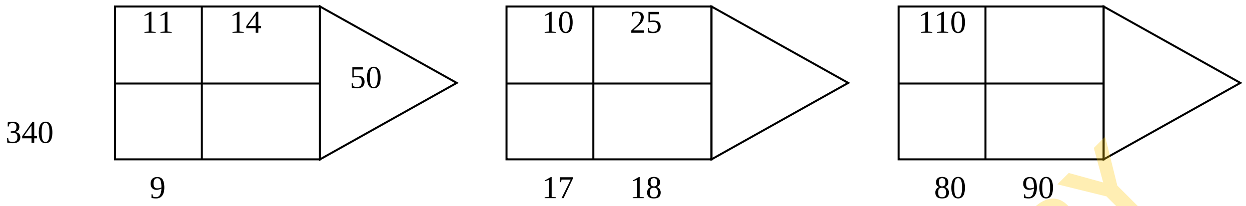
Then



Evaluation The pupils should:

1. Identify the mathematical operation involved in the following

2. Find the missing numbers.



Summary and Conclusion

The teacher summaries the lesson by solving the evaluation questions correctly for the pupils. He concludes the lesson by highlighting main pointing in finding missing numbers.

Home work: The pupils should do exercise 2a on page 4 of their quantitative reasoning book.

Week 3

Topic: Sum and difference in quantitative reasoning

Duration: 40 minutes

Specific objective: At the end of the lesson the pupils should be able to:

1. Find the sum any two given numbers
2. Find the difference of any two given numbers
3. Using sum and difference to find a missing numbers

Instructional Materials: Addition table and number line

Previous Knowledge: The pupils have learnt addition and subtraction of two or more digit numbers.

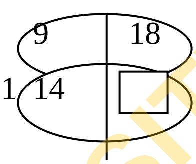
Presentation

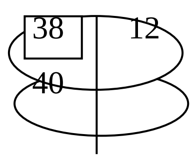
Step 1

The teacher revises the previous lesson with the pupils briefly in order to refresh their memory. The teacher then writes the topic of the day on the board and ask the pupils to say what they think it means.

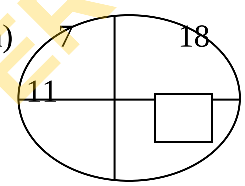
Step 2

Example 1

(a) 11 

(b) 10 

Soln.

(a) 

first identify the operation

Ans: Addition (+)

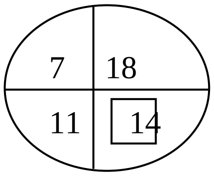
Then if 7 + 18 = 25

What can you do to 11 to get the answer as 14?

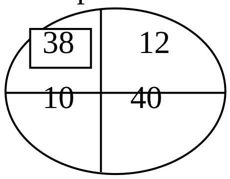
Ans: subtract 11 from 25

i.e: 25 – 11 = 14

∴



Example 2



Soln.

The number in the box is normally the answer

- What operations are involved?

  Ans: sum and difference = (+) and (-)

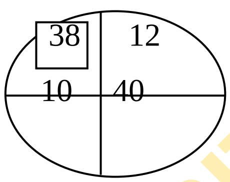
- What next?

  Ans: find the sum of 10 and 40

  10 + 40 = 50

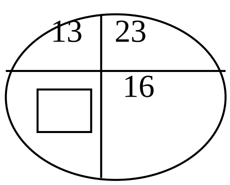
∴ 50 – 12 = 38

Hence



Evaluation: The pupils are asked to

1. Find the sum of 13 and 23
2. Find the difference of 36 and 16
3. Find the missing number in



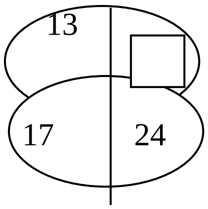
Summary The teacher summarizes the lesson as follows

- Sum of number is the result of adding the given numbers together
- Difference of numbers is the result of subtracting the smaller number from the bigger

- It is essential to first identify the operations involved in order to get a missing number.

Homework:

Solve the following

1.


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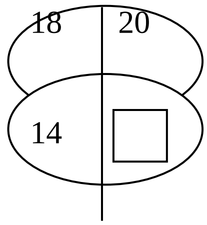

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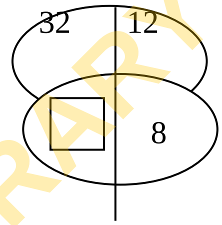

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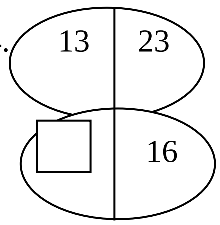

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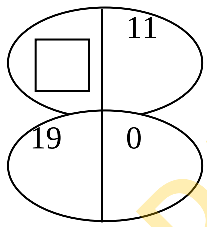

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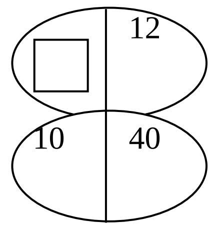


WEEK 4

Topic: Application of sum of quantities

Duration: 40 minutes

Objectives: At the end of the lesson the pupils should be able to:

1. State the mathematical operation required in a given problem
2. Solve any given quantitative reasoning problem.

Instructional Materials: Flash cards, flannel boards and number plates.

Previous knowledge: Pupils have learnt sum and difference

Presentation

Step 1

The teacher introduces the lesson of the day by write the topic on the board and asked the pupils to reason out the procedure for solving this:

15 —— 20

25 —— 30

The pupils take turns to say their answers.

Step 2

The teach leads the pupils to generate questions that can guide them to discover the procedure for themselves

15 —— 20

25 —— 30

Solution

The first question to as is, where does the answer lies?

Then indicate the answer with a square thus:

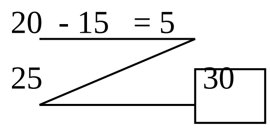
15 —— 20

25 —— [30]

Second question to ask yourself is, what is the operation involved?

- Try addition, does it work? No
- Try subtraction, does it work? Yes

Then

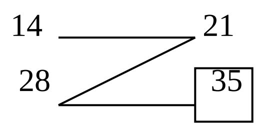


Hence 20 – 15 = 5

25 + 5 = 30

Step 3

Example 2:



Solution

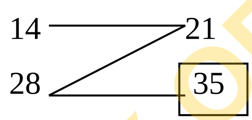
Ask yourself, where does the answer lies?

Ans: in the small square

Secondly ask yourself, what is the operations involved?

Ans: Try addition first, if it doesn't give the right answer

Try subtraction, multiplication or division until you get the right answer



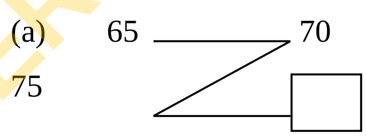
The operation involved is subtraction (-)

Hence

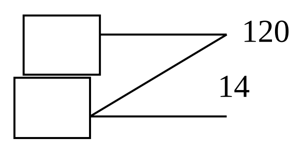
21 – 14 = 7 + 28 = 35

Evaluation: The pupil are asked to solve the following

1. (a)



2. (a)



(a) State the operations required (a) state the mathematical operation required

Summary: The teacher summaries the lesson by going through the main points in stating the mathematical operations required in a quantitative reasoning problem and solving for a given problem.

Homework: The pupils are to do exercise 5a on page 9 of their quantitative reasoning textbook.

Week 5

Topic: Application of division in quantitative reasoning

Duration: 40 minutes

Objectives: At the end of the lesson the pupils should be able to

1. Arrange the given quantitative as numerator and denominator.
2. Divide a given quantity correctly
3. Solve quantitative reasoning problems involving division

Instructional Materials: Division table, fruits and counters

Previous knowledge: The pupils have learnt addition and subtraction of quantities.

Presentation

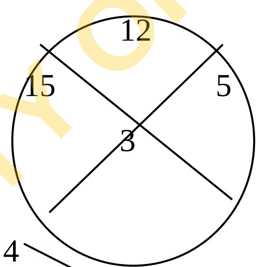
Step 1

The teacher welcomes the pupils to class and introduce the topic of the day: The teacher asks the pupils their understanding of the topic.

Step 2:

The teacher guides the pupils to find the following:

Example 1



$= 4 - 3 = 1$

$12 \div 3 = 4$

Subtract 3 from 4 equals 1

$15 \div 5 = 3$

What is numerator and denominator in 12 ÷3

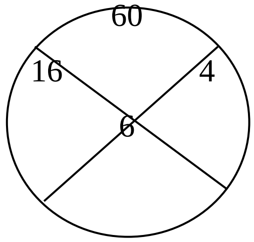
$\frac{12}{3}$ numerator / denominator

What is the numerator and denominator in 15 ÷ 5

$\frac{15}{5}$ numerator / denominator

Step 3

Example 2



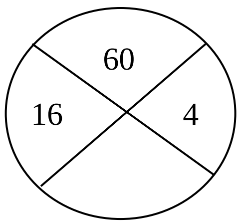
Solution

60 ÷ 6 = 10

Subtract 4 from 10

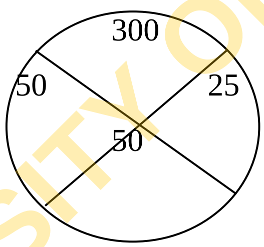
16 ÷ 4 = 4

∴



Step 3

Solve this



= 6 - ☐ ☐

First think of the operation involved

- Would it be addition, subtraction or division or all?

Let think like this

- Will 300 + 50 give us 6? No
- Will 300 – 50 give us 6? No
- Will 300 ÷50 give us 6? Yes

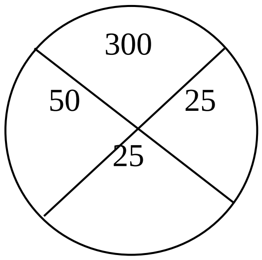
∴ The initial operation is division

Hence

300 ÷ 50 ⟩ = 6 - 2 = 4

While 50 ÷ 25

∴



= 6 - [2] = [4]

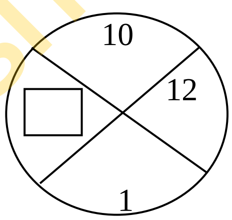
Evaluation

The pupils should answer the following

1. Arrange the following quantities as numerator and denominator
   - (a) 14 ÷ 7
   - (b) 3 ÷ 3
   - (c) 72 ÷ 24
2. Divide 14 by 7, 3 by 3 and 72 by 24 correctly.

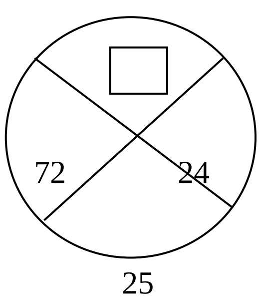
3. Solve

(a)

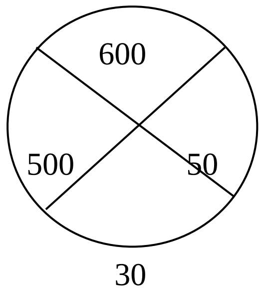


= 10 – 8 = 2

(b)



= 6 – 3 = 3

(c) 

= ☐ - 10 = ☐

Summary

The teacher summarized the lesson by highlighting main points on division of quantities and guiding the pupils through the evaluation questions.

Homework: Pupils should go home and do Exercise 17c on page 52 of their quantitative reasoning textbook

Week 6

Topic: Application of subtraction in quantitative reasoning

Duration: 40 minutes

Objectives: Pupils should be able to apply subtraction in solving quantitative reasoning problems.

Instructional materials: Different quantities of fruits, pebbles and counters

Previous knowledge: Pupils have learnt subtraction of two digit numbers.

Presentation

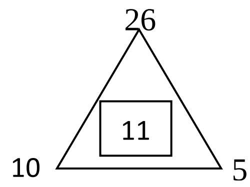
Step 1

The teacher welcomes the pupils to class, ask them to hand-in their home work and get ready for the day's topic as he writes the topic on the board

Step 2

The teacher explains the topic to the pupils and guides them to apply it in solving quantitative reasoning problems. Thus:

Example 1



The number in the square inside the triangle is normally the answer.

How can it be got

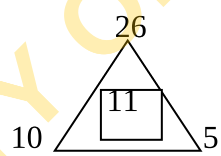
Let's think like this:

- Will 26 + 10 + 5 give us 11? No
- Will 10 + 5 x 26 give us 11? No
- Will 26 – 10 + 5 give us 11? Yes

Therefore the operations involved here are

Subtraction and addition

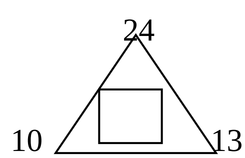
Hence



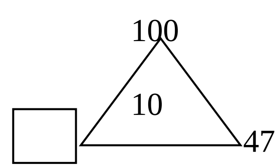
= 25 – 10 + 5
= 25 – 15
= 11

Step 2

Example: Solve (1)

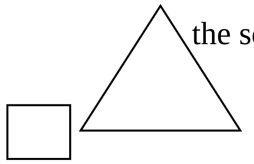


(2)



Solution

1. The first thing to do is to identify what is asked

So,  the square is where the answer should be.

Now,

How do we get it?

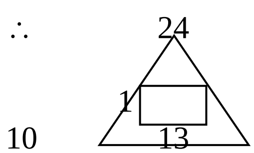
Let think like this

Will 24 + 10 + 13 give us the answer? No

Let try subtraction

24 – 10 + 13 = 1 Yes

∴



2. Similarly

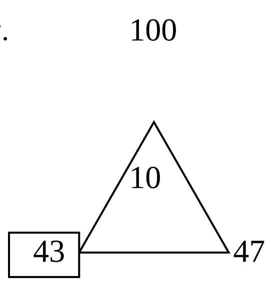
100 – 47 + □ 10

53 + □ 10

= □ – 10

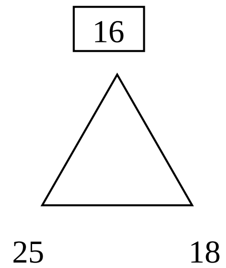
= □

∴



Step 3

Solve



Solution

The teacher guides pupils thus:

- ➢ What operations are required here?

Ans: Addition, 25 + 18

- ➢ What next?

Ans: subtract 43 from [ ] to get 16

- ➢ So what is [ ] ?

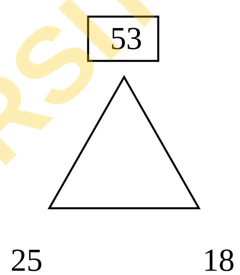
To get [ ] Let's say [ ] - 43 = 16 Add 43 to both sides

[ ] - 43 + 43 = 16 + 43

[ ] = 16 + 43

[ ] = 59

∴



Summary

The teacher summarized the lesson using the evaluation questions and explaining where pupils have difficulties.

Homework: Pupils should go home and practice exercise 17b on page 50 of their quantitative reasoning textbook.

Week 7

Topic:

Duration: 40 minutes

Objective: At the end of the lesson the pupils should be able to follow the number patter and fill in the gaps.

Instructional material: Number charts

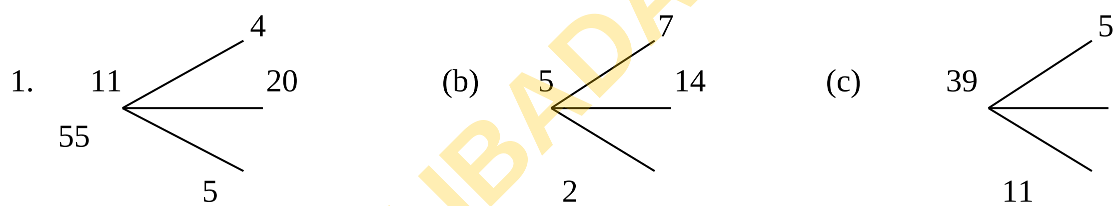
Previous knowledge: Pupils have learnt number patterns

Presentation

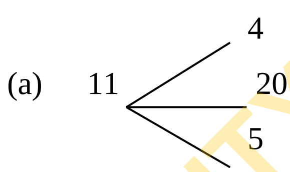
Step 1

Looking at the figure below, you would be able to identify the mathematical operation involve and figure out how to fill in the gaps.

Example 1



Solution



To solve this as yourself these question

- Where lies the answer
- What operation is involved
- Try addition: it is right?

If not try multiplication etc.

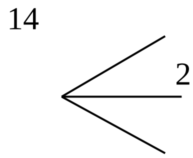
Therefore:

The answer lies in the highest number

The sum of 11, 4 and 5 = 20

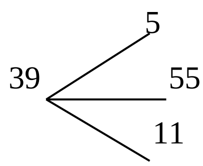
The operation is therefore addition

$\therefore$ 11 + 4 + 5 = 20



Recall (a) above

$\therefore$ 5 + 7 + 2 = 14

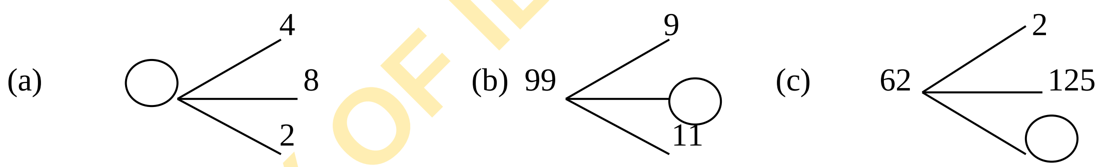
(c) 

Recall (a) above

$\therefore$ 39 + 5 + 11 = 5

Step 2

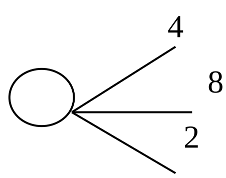
Looking at the figure below, fill the gap

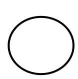


Solution

Reason out the following

- Where does the answer lies
- What operations are involved
- What number can fill the gap

(a) 

The answer lies in the  space provided

So let try addition and subtraction

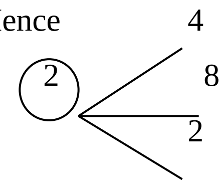
Represent the answer with letter K

$\therefore$ k + 4 + 2 = 8 Collect like terms k = 8 - 4 + 2

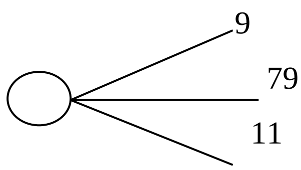
k = 8 – c

k = 2

Hence



(b) To fill the gap in



Recall the questions in (a) above

∴ represent the gap with letter ‘n’

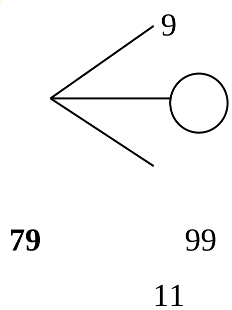
You will have:

79 + 9 + 11 = n

Hence n = 79 + 9 + 11

n = 99

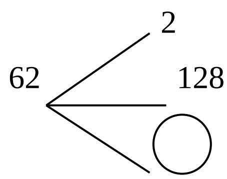
Therefore



Step 3

Example

Fill the gap in the figure below



Solution

Represent the missing number with letter b

∴ 62 + 2 + b = 128

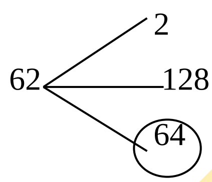
Collect like terms

b = 128 – 62 + 2

b = 128 – 64

b = 64

Hence

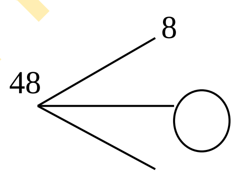


Evaluation

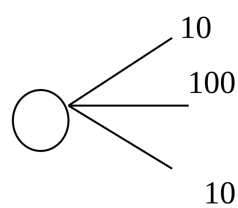
Pupils are asked to solve the following

1. Follow the number pattern and fill the gap

(a)



(b)



WEEK 8

Topic: Application of sum of quantities

Duration: 40 minutes

Objectives: At the end of the lesson the pupils should be able to:

3. State the mathematical operation required in a given problem
4. Solve any given quantitative reasoning problem.

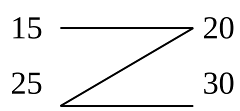
Instructional Materials: Flash cards, flannel boards and number plates.

Previous knowledge: Pupils have learnt sum and difference

Presentation

Step 1

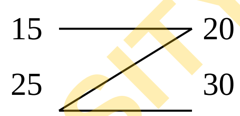
The teacher introduces the lesson of the day by write the topic on the board and asked the pupils to reason out the procedure for solving this:



The pupils take turns to say their answers.

Step 2

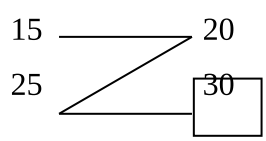
The teach leads the pupils to generate questions that can guide them to discover the procedure for themselves



Solution

The first question to as is, where does the answer lies?

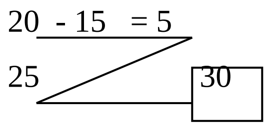
Then indicate the answer with a square thus:



Second question to ask yourself is, what is the operation involved?

- Try addition, does it work? No
- Try subtraction, does it work? Yes

Then

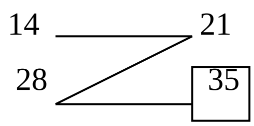


Hence 20 – 15 = 5

25 + 5 = 30

Step 3

Example 2:



Solution

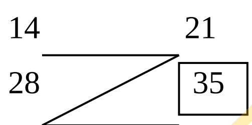
Ask yourself, where does the answer lies?

Ans: in the small square

Secondly ask yourself, what is the operations involved?

Ans: Try addition first, if it doesn't give the right answer

Try subtraction, multiplication or division until you get the right answer



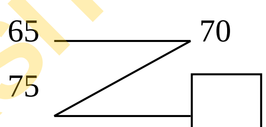
The operation involved is subtraction (-)

Hence

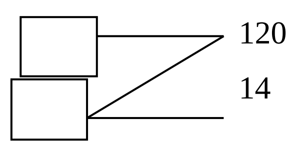
21 – 14 = 7 + 28 = 35

Evaluation: The pupil are asked to solve the following

(a)



(b)



(c) State the operations required

(d) state the mathematical operation required

Summary

The teacher summaries the lesson by going through the main points in stating the mathematical operations required in a quantitative reasoning problem and solving for a given problem.

Home Work:

The pupils are to do exercise 5a on page 9 of their quantitative reasoning text book.

TREATMENT PACKAGE

MODEL – LEAD –TEST STRATEGY

WEEK 1

Topic: Counting numbers in groups

Class: Primary 5

Time: 40 minutes

Specific objectives: At the end of the lesson the pupils should be able to:

1. Identify the difference among numbers in a given group or series.
2. Write the next missing numbers in a series

Instructional Materials: Counting board and counters.

Previous knowledge: Pupils already know how to count and write numbers from 1 – 1000.

Presentation

Welcome the pupils to class and sing with them an action song to get them ready for the lesson

"1, 2, 3, 4, 5
Catching fishes all alive
Why do you let them go
Because they bite my finger so."

Step 1: I do it – the model

The teacher models, counting in series or group

Thus

15, 20 — 5   25, 30 — 5   35, 40 — 5

The difference between each of the pair of numbers is 5

20, 25 — 5   30, 35 — 5

The difference between these pairs of number is also 5. Therefore this series is counted in groups of 5^s.

Step 2: We do it – the Lead

The teach leads the pupils to count in series or groups.

Thus

Lets do this together.

21, 31, 41, 51, 61, 71

What is the difference between these groups

21, 31 — 10 | 41, 51 — 10 | 61, 71 — 10

Notice that the numbers in this series are counted a group of 10^s.

Step 3: You do it - the test

The teacher tests the pupils to count in groups

100, 200, 300, 400, 500, 600

The teacher goes round to check the pupil's work

Thus

100 200 — 100 | 300 400 — 100 | 500 600 — 100

Between each pair of numbers we counted 100 meaning that this series is counted in group of 100.

Evaluation

1. Identify the difference among numbers in the following series or group
   a. 60, 70, 80, 90, 100, 110
   b. 160, 165, 170, 175, 180, 185
2. Write the next missing numbers in the following series
   a. 530, 532, 534, _____, 538, _____
   b. 790, _____, 810, 820, ____, _____

Summary

The teacher used the evaluation equations as summary to the lesson by repeating the model-lead-test process in steps 1, 2 and 3 for pupils to master it.

WEEK 2

Topic: Number in bases

Class: Primary 5

Time: 40 minutes

Specific objectives: At the end of the less the pupils should be able to:

4. Count a given set of numbers in group
5. Identify the difference among the number in the group
6. Write the missing numbers in the group.

Instructional material: Counters

Previous Knowledge: The pupils already know how to count and write numbers from 1 – 1000.

Presentation

Step 1

The teacher welcomes the pupils to class and tries to make them relax from any form of environmental anxiety. The teacher guide them to sing an action song to make them alert for the lesson

"1, 2, 3, 4, 5
Catching fishes all alive
Why do you let them go?
Because they bite my finger so.
Which finger did they bite?
The little finger on my right"

Step 2

The teacher writes the topic on the board. Ask the pupils to say what they think the topic means. As the pupils say what they think the teachers writes the correct ones on the board. When pupils say an incorrect one, the teacher explains why it is not correct and guides the pupils on how to go about it.

Step 3

The teacher writes the following number series on the board.

e. 15, 20, 25, 30, 35, 40
f. 21, 31, 41, 51, 61, 71

g. 100, 200, 300, 400, 500, 600

Example (a)

The teacher asks the pupils to look at the number in (a) 15, 20, 25, 30, and 40

Then

4. Say the numbers out loud
5. What is the amount of number to add to 15 to get 20 (ans. = 5)
6. What will you add to 35 to get 40 (ans. = 5)

What can you discover here now

Ans.: (i) to get the next number 1 must add 5 to the previous number

(ii) this is counting in 5s

Example 2

b. 21, 31, 41, 51, 61, 71

Solution

The teacher guides the pupils by asking them some leading question to help them discover the right answers.

5. Can you say the numbers in this series aloud?
6. What is the difference between 21 and 31 (31 – 21 = 10)
7. What is the difference between 61 and 71 (71 – 61 = 10)
8. What have you discover here?

Answer: The difference between the numbers is 10

The numbers are counted in 10s

Example 3

h. 100, 200, 300, 400, 500 and 600

Solution

The teacher guides the pupils to discover the right answers by generating the following questions.

5. What are the numbers in this series (100, 200, 300, 400, 500)
6. What is the difference between the first number and the second?

   200 – 100 = 100
7. What is the difference between the last two numbers

   600 – 500 = 100

8. What have you discovered

Ans: (i) If 1 add 100 to any of the numbers I will get the next number

(ii) The numbers are counted in 100s.

Step 3

The teacher guides the pupils to fill in missing numbers in a given series.

Example 1: 150, _____, 250, _____, ______. 400

Solution:

- What is the first number there? Ans: 150
- What is the next number? Ans: it is missing _____
- After the _____ what number do you have there? Ans: 250
- What is the difference between 150 and 250? Ans: 250-150 = 100
- How many steps will you move from 150 to 250 as in the series? Ans: 2 steps.
- If you divide 100 by 2 what do you have? Ans: 50
- Now try to had 50 to each number and see what you get.
- What have you discovered.

3. Adding 50 to the first number gives the next missing number which is 200. Add 50 to 200 gives the next number 250, adding 50 to 250 gives the next missing number which is 300. The next missing number therefore is 350.
4. The numbers therefore were counted in 50s.

Evaluation: The teacher evaluated the lesson by asking the pupils to do the following

4. Count the numbers in the following group
   c. 60, 70, 80, 90, 100, 110
   d. 160, 165, 170, 175, 180, 185
5. Identify the difference in the group of numbers in a and b above
6. Write the missing numbers in the following group of numbers
   c. 530, 532, 534, _____, 538, ______
   d. 790, _____, 810, 820, ____, _____

Summary

The teacher summaries the lesson by solving the evaluation questions correctly for the pupils and guiding them to think critically on each question by generating some leading question that will guide them to discover answers for themselves.

Homework:

Pupils should go home and do exercise 1 on page 3 of their quantitative reasoning textbook.

WEEK 3

Topic: Division of quantities

Duration: 40 minutes

Objectives: At the end of the lesson the pupils should be able to

4. Arrange the given quantitative as numerator and denominator.
5. Divide a given quantity correctly
6. Solve quantitative reasoning problems involving division

Instructional Materials: Division table, fruits and counters

Previous knowledge: The pupils have learnt addition and subtraction of quantities.

Presentation

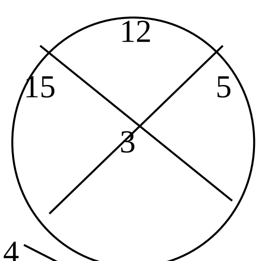
Step 1

The teacher welcomes the pupils to class and introduce the topic of the day: The teacher asks the pupils their understanding of the topic.

Step 2:

The teacher guides the pupils to find the following:

Example 1



= 4 - 3 = 1

12 ÷ 3 = 4

Subtract 3 from 4 equals 1

15 ÷ 5 = 3

What is numerator and denominator in 12 ÷3

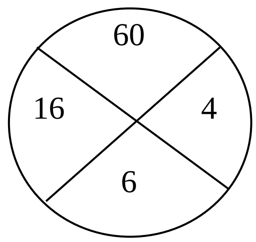
12	numerator
3	denominator

What is the numerator and denominator in 15 ÷ 5

15	numerator
5	denominator

Step 3

Example 2



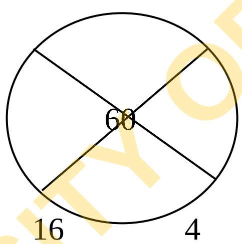
Solution

60 ÷ 6 = 10

Subtract 4 from 10

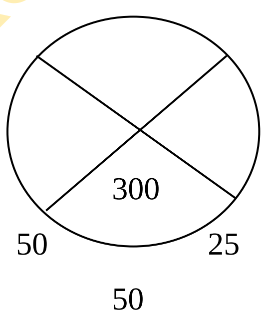
16 ÷ 4 = 4

∴



Step 3

Solve this



= 6 - ☐ ☐

First think of the operation involved

- Would it be addition, subtraction or division or all?

Let think like this

- Will 300 + 50 give us 6? No
- Will 300 – 50 give us 6? No
- Will 300 ÷50 give us 6? Yes

∴ The initial operation is division

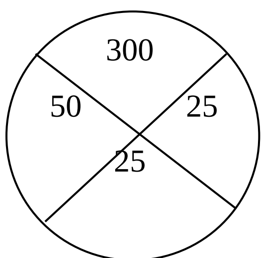
Hence

300 ÷ 50

= 6 - 2 = 4

While 50 ÷ 25

∴



= 6 - 2 = 4

Evaluation

The pupils should answer the following

4. Arrange the following quantities as numerator and denominator

(d) 14 ÷ 7

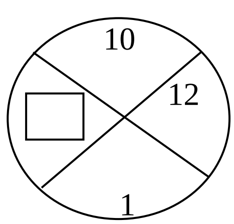
(e) 3 ÷ 3

(f) 72 ÷ 24

5. Divide 14 by 7, 3 by 3 and 72 by 24 correctly.

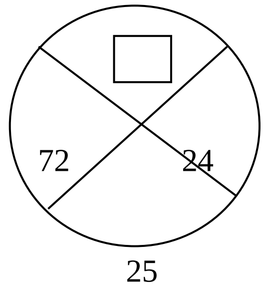
6. Solve

(d)



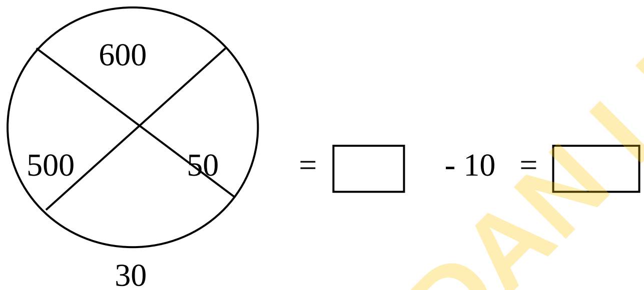
= 10 – 8 = 2

(e)



= 6 – 3 = 3

(f)



Summary

The teacher summarized the lesson by highlighting main points on division of quantities and guiding the pupils through the evaluation questions.

Homework: Pupils should go home and do Exercise 17c on page 52 of their quantitative reasoning textbook

WEEK 4

Topic: Application of sum of quantities

Duration: 40 minutes

Objectives: At the end of the lesson the pupils should be able to:

5. State the mathematical operation required in a given problem
6. Solve any given quantitative reasoning problem.

Instructional Materials: Flash cards, flannel boards and number plates.

Previous knowledge: Pupils have learnt sum and difference

Presentation

Step 1

The teacher introduces the lesson of the day by write the topic on the board and asked the pupils to reason out the procedure for solving this:

15 20

25 30

The pupils take turns to say their answers.

Step 2

The teach leads the pupils to generate questions that can guide them to discover the procedure for themselves

15 20

25 30

Solution

The first question to as is, where does the answer lies?

Then indicate the answer with a square thus:

15 20

25 [30]

Second question to ask yourself is, what is the operation involved?

- Try addition, does it work? No
- Try subtraction, does it work? Yes

Then

20 - 15 = 5

25 [30]

Hence 20 – 15 = 5

25 + 5 = 30

Step 3

Example 2:

14 21

28 [35]

Solution

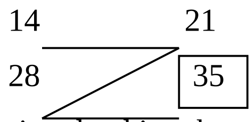
Ask yourself, where does the answer lies?

Ans: in the small square

Secondly ask yourself, what is the operations involved?

Ans: Try addition first, if it doesn't give the right answer

Try subtraction, multiplication or division until you get the right answer



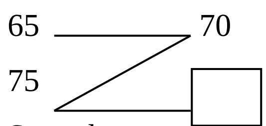
The operation involved is subtraction (-)

Hence

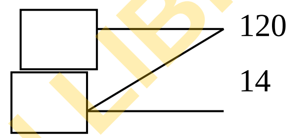
21 – 14 = 7 + 28 = 35

Evaluation: The pupil are asked to solve the following

(a)



(b)



(c) State the operations required

(d) state the mathematical operation required

Summary

The teacher summaries the lesson by going through the main points in stating the mathematical operations required in a quantitative reasoning problem and solving for a given problem.

Homework: The pupils are to do exercise 5a on page 9 of their quantitative reasoning textbook

WEEK 5

Topic:

Duration: 40 minutes

Objective: At the end of the lesson the pupils should be able to follow the number patter and fill in the gaps.

Instructional material: Number charts

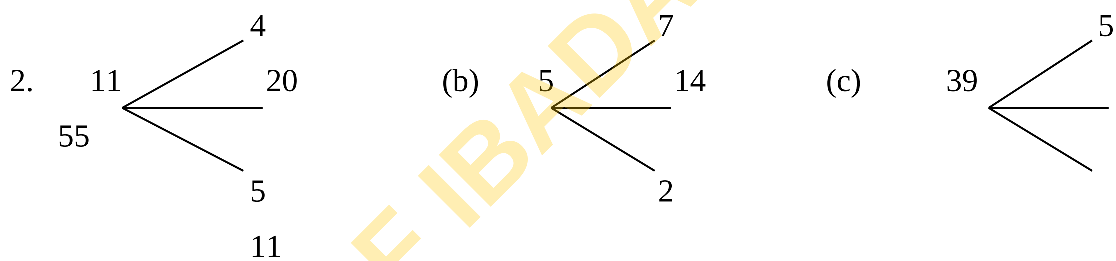
Previous knowledge: Pupils have learnt number patterns

Presentation

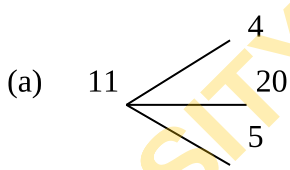
Step 1

Looking at the figure below, you would be able to identify the mathematical operation involve and figure out how to fill in the gaps.

Example 1



Solution



To solve this as yourself these question

- Where lies the answer
- What operation is involved
- Try addition: it is right?

If not try multiplication etc.

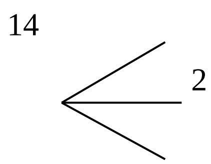
Therefore:

The answer lies in the highest number

The sum of 11, 4 and 5 = 20

The operation is therefore addition

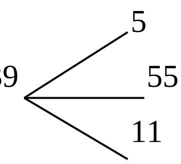
$\therefore$ 11 + 4 + 5 = 20



Recall (a) above

∴ 5 + 7 + 2 = 14

(c) 39



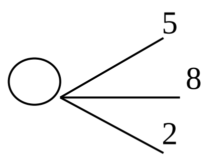
Recall (a) above

∴ 39 + 5 + 11 = 5

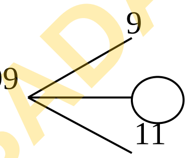
Step 2

Looking at the figure below, fill the gap

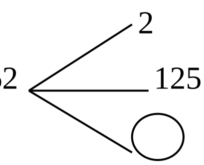
(a)



(b) 99



(c) 62

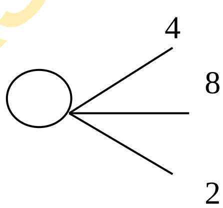


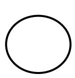
Solution

Reason out the following

- Where does the answer lies
- What operations are involved
- What number can fill the gap

(c)



The answer lies in the  space provided

So let try addition and subtraction

Represent the answer with letter K

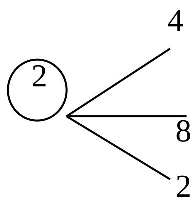
∴ k + 4 + 2 = 8 Collect like terms

k = 8 - 4 + 2

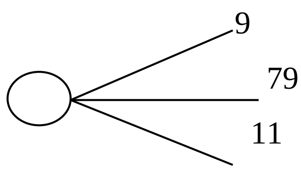
k = 8 – c

k = 2

Hence



(d) To fill the gap in



Recall the questions in (a) above

∴ represent the gap with letter 'n'

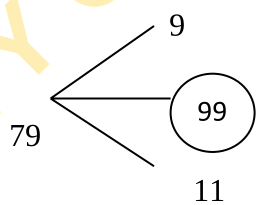
You will have:

79 + 9 + 11 = n

Hence n = 79 + 9 + 11

n = 99

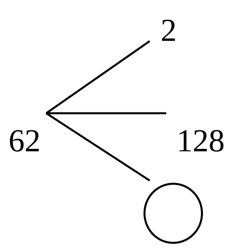
Therefore



Step 3

Example

Fill the gap in the figure below



Solution

Represent the missing number with letter b

$\therefore$ 62 + 2 + b = 128

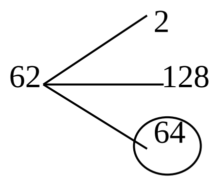
Collect like terms

b = 128 – 62 + 2

b = 128 – 64

b = 64

Hence

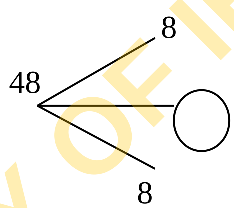


Evaluation

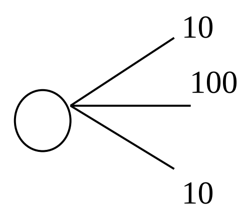
Pupils are asked to solve the following

2. Follow the number pattern and fill the gap

(b)



(b)



WEEK 6

Topic: Application of subtraction in quantitative reasoning

Duration: 40 minutes

Objectives: Pupils should be able to apply subtraction in solving quantitative reasoning problems.

Instructional materials: Different quantities of fruits, pebbles and counters

Previous knowledge: Pupils have learnt subtraction of two-digit numbers.

Presentation

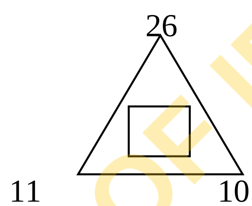
Step 1

The teacher welcomes the pupils to class, ask them to hand-in their homework and get ready for the day's topic as he writes the topic on the board.

Step 2

The teacher explains the topic to the pupils and guides them to apply it in solving quantitative reasoning problems. Thus:

Example 1



The number in the square inside the triangle is normally the answer.

How can it be got

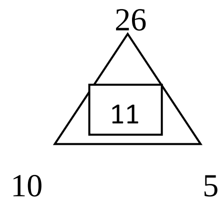
Let's think like this:

- Will 26 + 10 + 5 give us 11? No
- Will 10 + 5 x 26 give us 11? No
- Will 26 – 10 + 5 give us 11? Yes

Therefore the operations involved here are

Subtraction and addition

Hence



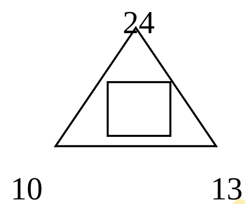
= 25 – 10 + 5

= 25 – 15

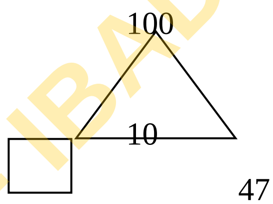
= 11

Step 2

Example: Solve (1)



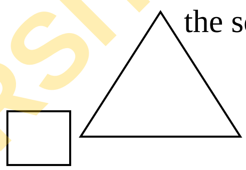
(2)



Solution

3. The first thing to do is to identify what is asked

So, the square is where the answer should be.



Now,

How do we get it?

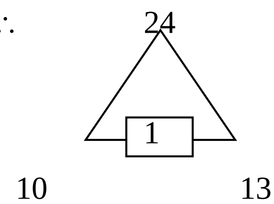
Let think like this

Will 24 + 10 + 13 give us the answer? No

Let try subtraction

24 – 10 + 13 = 1 Yes

∴



4. Similarly

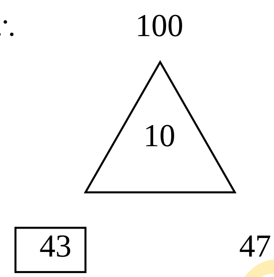
100 – 47 + ☐ 10

53 + ☐ 10

☐ = 53 – 10

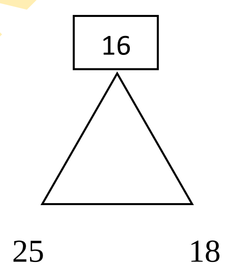
☐ = 43

∴



Step 3

Solve



Solution

The teacher guides pupils thus:

- What operations are required here?

Ans: Addition, 25 + 18

- What next?

Ans: subtract 43 from $\square$ to get 16

- So what is $\square$?

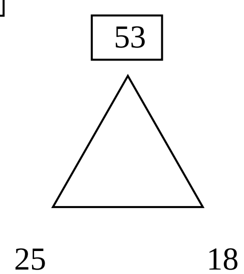
To get $\square$ Let's say $\square - 43 = 16$ Add 43 to both sides

$\square - 43 + 43 = 16 + 43$

$\square = 16 + 43$

$\square = 59$

∴



Summary

The teacher summarized the lesson using the evaluation questions and explaining where pupils have difficulties.

Homework: Pupils should go home and practice exercise 17b on page 50 of their quantitative reasoning textbook.

WEEK 7

Topic: Application of division in quantitative reasoning

Duration: 40 minutes

Objectives: At the end of the lesson the pupils should be able to

7. Arrange the given quantitative as numerator and denominator.
8. Divide a given quantity correctly
9. Solve quantitative reasoning problems involving division

Instructional Materials: Division table, fruits and counters

Previous knowledge: The pupils have learnt addition and subtraction of quantities.

Presentation

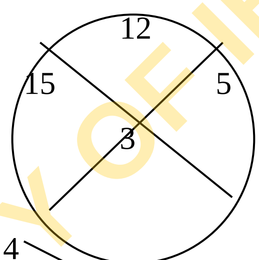
Step 1

The teacher welcomes the pupils to class and introduce the topic of the day: The teacher asks the pupils their understanding of the topic.

Step 2:

The teacher guides the pupils to find the following:

Example 1



= 4 - 3 = 1

12 ÷ 3 = 4

Subtract 3 from 4 equals 1

15 ÷ 5 = 3

What is numerator and denominator in 12 ÷3

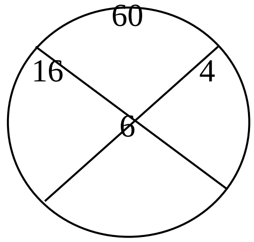
$\frac{12}{3}$ 12 numerator, 3 denominator

What is the numerator and denominator in 15 ÷ 5

$\frac{15}{5}$ 15 numerator, 5 denominator

Step 3

Example 2



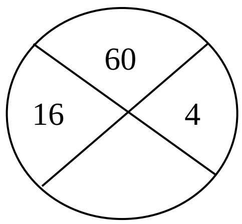
Solution

60 ÷ 6 = 10

Subtract 4 from 10

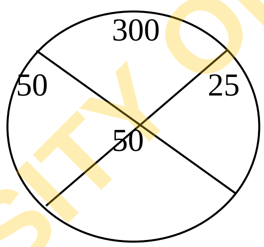
16 ÷ 4 = 4

∴



Step 3

Solve this



= 6 - □ □

First think of the operation involved

- Would it be addition, subtraction or division or all?

Let think like this

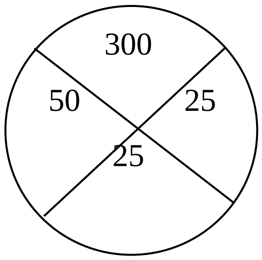
- Will 300 + 50 give us 6? No
- Will 300 – 50 give us 6? No
- Will 300 ÷50 give us 6? Yes

∴ The initial operation is division

Hence

300 ÷ 50 ⟩ = 6 - 2 = 4

While 50 ÷ 25

∴ 

= 6 - 2 = 4

Evaluation

The pupils should answer the following

7. Arrange the following quantities as numerator and denominator

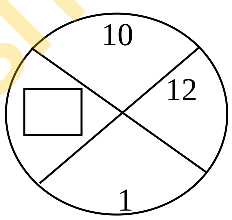
(g) 14 ÷ 7

(h) 3 ÷ 3

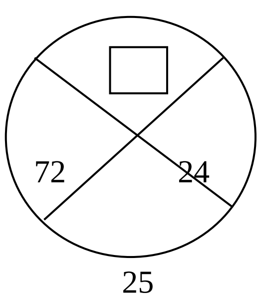
(i) 72 ÷ 24

8. Divide 14 by 7, 3 by 3 and 72 by 24 correctly.

9. Solve

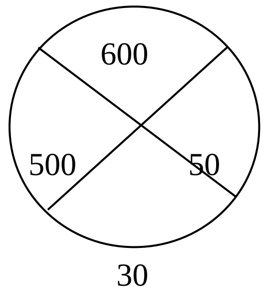
(g) 

= 10 – 8 = 2

(h) 

= 6 – 3 = 3

(i)



= ☐ - 10 = ☐

Summary

The teacher summarized the lesson by highlighting main points on division of quantities and guiding the pupils through the evaluation questions.

Homework: Pupils should go home and do Exercise 17c on page 52 of their quantitative reasoning textbook

WEEK 8

Topic: Finding missing numbers

Duration: 40 minutes

Specific objectives: At the end of the lesson the pupils should be able to:

3. Identify the mathematical operation(s) involved
4. Find the missing number

Instructional materials: Counters, addition table and flannel board.

Previous knowledge: The pupils already know how to count numbers and use addition tables.

Presentation

Step 1

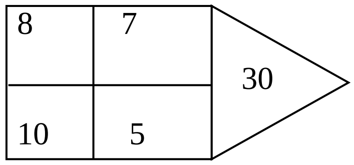
The teacher gets the pupils set for the lesson by singing with them an action song that is familiar to the pupils.

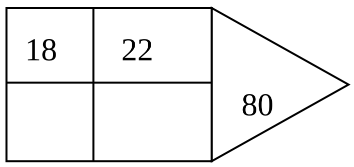
"There were 2 black birds
Sitting on the wall
One named Peter, One name Paul
Fly away Peter, fly away Paul
Oh come back Peter, Oh come back Paul

On come back my 2 black birds and sit on the wall?

Step 2

The teacher writes the following examples on the board and ask the pupils to think about it in a few minutes.

4. 

5. 

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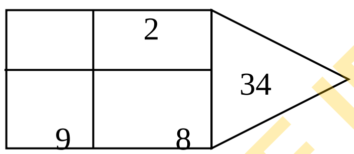
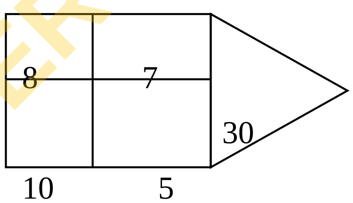
6. 

Step 3

The teacher guides the pupils to discover the mathematical operation involved in each of the examples above.

Example 1:



The number in the triangle at the right hand side is normally the answer. To get than what do you do?

The teacher allows the pupils to think that out for themselves. Then begins to guide them thus:

- What mathematical operation do you think is involved here?
- Try adding the numbers in column and in row

That is

8 + 7 = 15
30
10 + 5 = 15

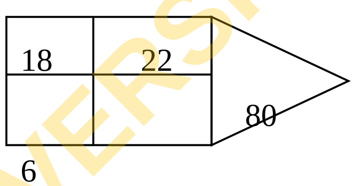
Then

8 + 10 = 18
30
7 + 5 = 12

It means that:

- Mathematical operation is addition (+)
- Both row and column addition give 30 the answer

Example 2



The number in the triangle is the answer (80)

The teacher guides the pupils with the following question:

- What is the operation involved?

  Ans: Addition (+)

- How would you get the missing number?

  Ans: Add all the numbers in the rectangle

18 + 22 + 6 = 46

- What next?

Ans: Form and equation using ‘a’ for the missing number. Thus

46 + a = 80

Subtract 46 from both sides of the equality sign

46 – 46 + a = 80 – 46

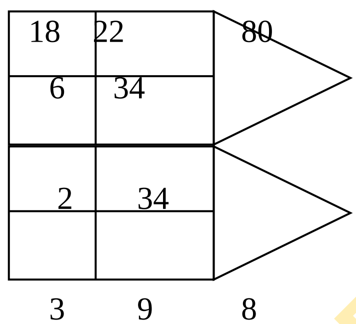
0 + a = 80 – 46

∴ a = 80 - 46

a = 34

∴

Example 3



The teacher guides the pupils to find the missing number

Thus:

- What is the operation involved?

Ans: Addition (+)

- What will you represent the missing number with?

Ans: (x)

- Column addition: x + 2 = x + 2 34
- Row addition: 9 + 8 = 17
- What next?

Ans: Form and equation

x + 2 + 19 = 34

x + 19 = 34

Subtract 19 from both sides

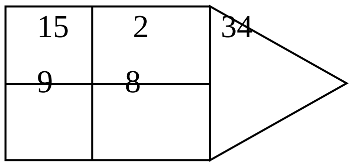
x + 19 – 19 = 34 – 19

x + 0 = 34 – 19

x = 34 - 19

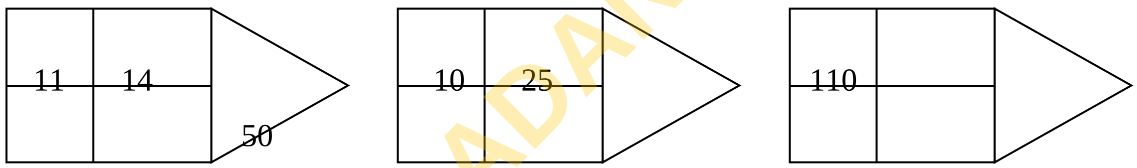
∴ x = 15

Then



Evaluation The pupils should:

3. Identify the mathematical operation involved in the following
4. Find the missing numbers.



340

9   17   18   80   90

Summary and Conclusion

The teacher summaries the lesson by solving the evaluation questions correctly for the pupils. He concludes the lesson by highlighting main pointing in finding missing numbers.

Home work: The pupils should do exercise 2a on page 4 of their quantitative reasoning book.

TREATMENT FOR THE CONTROL GROUP

Control group (conventional lecture method)

The treatment here includes the following steps:

Step 1

The teacher introduces the lesson by asking the pupils questions on the previous lesson.

Step 2

Pupils listen passively as the teacher discusses the new lesson's content

Step 3

The teacher evaluates the lesson by asking pupils oral questions to ascertain the change in the initial change in their quantitative reasoning skills of the pupils

Step 4

The teacher gives a brief oral review of the lesson taught. Thereafter the teacher asks the pupils to write the content notes.

The teacher then gives a take home assignment to pupils.

APPENDIX VIII

TRAINING GUIDE FOR RESEARCH ASSISTANTS

Date: January 16, 2019

Venue: Early Childhood Lab 1 Uniuyo

Time: 2 .30 pm daily

Day 1

Introduction

The training sessions are specifically for those who have willingly agreed to take part in this research work, by completing the research assistants consent form (RACF). You are all welcome to this training session. I thank you for your willingness to participation in this research and for taking out time to attend this training.

Session 1

- General Introduction
  - The research introduces himself
  - The research assistants introduce themselves in turns stating their – names, school, class taught and level of preparedness to take part in the study.
  - The researcher states:
    - Purpose of the study
    - Participants in the study
    - Mode of selection of participant
    - Benefit of the study
    - Duration of the study

Question and answer time

- Research assistance are allowed time to interact with the research by way of asking questions for clarifications.
- Any other relevant matter.

Day 1

Session II

- Screening Instruments
    - The research introduces the screening instruments to the research assistants and educate them on how to administer the instrument to individual pupils.
- Slossan intelligence Test – Revised
    - This is to be used for screening pupils for intelligence
    - It is a quick, reliable and valid measure of intelligence
    - It is an individual screening intelligence test
    - Determine the pupil's chronological age by subtracting date of birth from the date of testing
    - Determine Basal age after questions involving ten (10) passes in a row
    - When ten (10) item in a row are missed the testing is completed then the ceiling item determined
- Pupils Rating Scale – Revised
- Kaufman test of Educational Achievement 2nd Edition
- Mathematics Anxiety Scale for Children
- Quantitative Reasoning Deficit Scale
- Pretest – Posttest
    - Quantitative Reasoning Achievement Test

Day Two

Session 1

- Main Treatment
- Guided discovery strategy
- Model-lead-test strategy

Day Two

Session II

- Commencement of Actual Screening using
  - Slossan intelligence test (S 17)
  - Pupils' Rating scale (PRS)

Day Three

Session 1

- Screening using
  - Kaufman test of Educational Achievement 2^{nd} Ed. (KTEA – 2^{nd} Ed.)
  - Mathematics Anxiety Scale for Children (MASC)
  - Quantitative Reasoning Deficit Scale (QRDS)

Day Four and Five

- Selection of actual participants – 20 pupils per school
- Administration of pretest using the Quantitative Reasoning Achievement Test (QRAT).
- **Closing**