EFFECTS OF CONSTRUCTIVIST TEACHING STRATEGY ON ADDITION AND SUBTRACTION SKILLS IN MODEL PRIMARY SCHOOLS OF KADUNA STATE

BY

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DECLARATION

I, Ado Ishaku Kauru, do solemnly declare that this thesis titled "Effect of Constructivist Teaching Strategy on Addition and Subtraction Skills in Model Primary Schools of Kaduna State" has been vividly written by me and is my handwork. No part of this thesis was previously presented for another degree at any university.

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ADO ISHAKU KAURU	SIGNATURE	DATE

DEDICATION

This study is dedicated to parents, family and all those who have contributed immensely towards the success of this thesis and my education.

CERTIFICATION

This thesis titled “Effect of Constructivist Teaching Strategy on Addition and Subtraction Skills in Model Primary Schools of Kaduna State” by Ado Ishaku Kauru meets the requirements and regulations governing the award of the Degree of Masters of Education (Mathematics Education) of Ahmadu Bello University, ABU, Zaria. Therefore, it is hereby approved for its contribution to knowledge.

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ABSTRACT

The aim of this study was to investigate the effects of constructivist teaching strategy on Addition and Subtraction Skills in model primary schools of Kaduna state (2006/2007). To achieve this, a pretest and posttest control group design was adopted. Two schools were randomly selected i.e. Shehu Idris Central and Kauru Central, which are experimental and control group respectively. A stratified random sampling technique was used and a total of 80 pupils were selected as sample size of the study. Five hypotheses and research questions were formulated to investigate the effects between the constructivist teaching strategy and the traditional method on addition and subtraction skills. The Statistical Package for Social Science was used for the analyses of data. A test- retest reliability and Pearson Correlation Coefficient was used to estimate the reliability and found to be 0.81 while the content validity coefficient was found to be 0.52. Independent Samples Test was used to test the hypotheses. The results indicated that there was statistically significant differences between the mean scores of the experimental and control groups in addition, subtraction skills, in the combination of addition and subtraction skills, and between male experimental and female experimental groups at $\alpha = 0.05$ level of significance which further showed that the Tri-constructs teaching strategy favoured the experimental group. Based on the results of the study some pertinent recommendations were made favourably to pupils, teachers, administrators and community members.

LIST OF TABLES

TABLE PAGE

LIST OF APPENDICES

APPENDICES PAGE

TABLE OF CONTENTS **PAGE**

CHAPTER 2. LITERATURE REVIEW

CHAPTER 4 RESULTS AND DISCUSSION

CHAPTER 5 SUMMARY, CONCLUSION AND RECOMMENDATION

ABBREVIATIONS

NCTM: National Council of Teachers of Mathematics

NRC: National Research Council

MSEB: Mathematical Science Education Board**.**

KSUBEB: Kaduna State Universal Basic Education Board.

SSSCE: Senior Secondary School Certificate Examination.

SPSS: Statistical Package for the Social Sciences.

ATDL: Average Test Difficulty Level.

CORI: Concept – Oriented Reading Instruction

OPERATIONAL DEFINITION OF TERMS

CONSTRUCTIVISM

Emphasizes the building (i.e. the construction) that occurs in pupil's mental structure when they learn mathematics.

LEVEL 1 ACHIEVEMENT TEST

A test given to both experimental and control groups drawn from the teachers' note of lessons and mathematics Book Three to find out the homogeneity of the groups.

LEVEL 2 ACHIEVEMENT TEST

A test designed by the researcher and administered to both experimental and control groups after the teaching of the tri- constructs strategy to only the experimental group.

ADDITION SKILLS

The ability to collect and put numbers or things together is called addition. Under the tri- constructs teaching strategy the addition skills were divided into three sections viz. Concrete materials, expanded notation without the concrete materials and the conventional notation.

SUBTRACTION SKILLS

The ability to reduce or decrease numbers or things is called subtraction. Under the tri- constructs teaching strategy, the subtraction skills were divided into three sections viz. concrete materials, expanded notation without the concrete materials and the conventional notation.

MODEL PRIMARY SCHOOLS

These are schools that were located in each of the local government areas of the state with a considerate attention in terms of funding and staffing.

TRI-CONSTRUCTS STRATEGY.

A teaching strategy designed by the researcher to be used as Treatment (X) to only the experimental group for a period of 8 weeks. It used the principles of constructivist teaching strategy in addition and subtraction skills that is concrete operational stage, expanded notation without the concrete materials and conventional stage.

TRADITIONAL METHOD

It is the old form of teaching instruction where the operations are shown horizontally or vertically with or without the help of Abacus.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study.

Mathematics education is established worldwide as a major area of study with numerous dedicated journals and conferences serving national and international communities of scholars. Research in mathematics education is also becoming more theoretically orientated. Studies in mathematics education consist of research contributions based on disciplines or multi-disciplinary perspectives that link theory with practice (Ernest, 1991). The studies also aim at having a major impact on the development of mathematics education as a field of study into the 21st Century (Ernest, 1994).

Constructivism**,** as its name implies, emphasizes the building (i.e. the construction) that occurs in pupil's minds when they learn. A simple way to summarize this idea is to refer to Gestalt theory; that is, the idea that 'a whole is different from the sum of its parts (Bencze, 2005). "Students need to construct their own understanding of each mathematical concept, so that the primary role of teaching is not to lecture, explain, or otherwise attempt to transfer mathematical knowledge to situations for students that will foster their making the necessary mental constructions" National Council of Teachers of Mathematics (NCTM, 1996,p.27).

In contrast, constructivism focuses our attention on how pupils learn. The challenge in teaching mathematics is to create experience that engages the student and supports his or her own explanation, evaluation, communication and application of mathematical models needed to make suite of these experiences (Hein, 1991). The fundamental challenge of constructivism is changing the locus of control over learning from the teacher to the student; it is not surprising that constructivism has a strong voice in current dialogue on mathematics education (Duffy & Perry, 1995).

It is pertinent to know that there are many approaches to improve teaching. We look for different ways to engage individual students, develop rich environments for exploration, prepare coherent problem sets and challenges that focus the model building effort, elicit and communicate student perceptions and interpretations (Duffy & Jonassen, 1995). Therefore, this study deems it fit to adopt the constructivist theory (Piagean theory) to study the effects of constructivist teaching strategy on addition and subtraction skills in Model primary schools of Kaduna State.

However, mathematics is a study of patterns and relationships; a science and a way of thinking; an art that is characterized by order and internal consistency; a language, using a tool for national development (NCTM, 1991, P.22). Learning of mathematics does not simply mean receiving and remembering of transmitted message; instead, "educational research offer compelling evidence that students learn mathematics well only when they construct their own mathematical understanding" (Mathematical Science Education Board, 1989, P.58). When educators begin to see learning as knowledge construction, their thinking about curriculum, instruction and assessment will change thus developing more approaches to connecting thinking and mathematics, and designing more mathematically significant instructional learning experiences. Such learning experiences are:

- Hands-on; involving students in really doing mathematics- experimenting first hand with physical objects in the environment and having concrete experience before learning abstract mathematical concepts.
- Minds-on; focusing on the core concepts and critical thinking processes needed for students to create and re-create mathematical concepts in there own minds.
- Authentic; allowing students to explore, discover, discuss and meaningfully construct mathematical concepts and relationships in contexts that involves real-world problems and projects that are relevant and interesting to the learner (NCTM, 1991,P.25).

Finally all goals point to one primary goal, all pupils will gain "mathematical power". That is an individual's abilities to explore, conjecture and reason logically, as well as the ability to use a variety of mathematical methods to solve no routine problems

1.2 Statement of the Problem.

Over the years, the teaching/learning of mathematics at all levels of education in Nigeria has grown and brought with it many instructional strategies. Yet, the students/pupils interest, attitude, performance and achievement towards mathematics at primary and secondary levels have remained a topic of concern (Adetula, 1987). There is problem of lack of understanding the postulated Piaget's constructivist teaching strategy on addition and subtraction in mathematics at primary levels. Also pupils always find it difficult to add and subtract numbers involving renaming. Again, there is problem of gender performance in mathematics not only in primary schools but all levels of education in Nigeria. There is the problem of discovery method for teaching commutative and associative additive properties at primary school level (Adetula, 1986). However, it was against these backgrounds that his study investigated effects of constructivist teaching strategy on mathematics addition and subtraction skills in Model primary schools of Kaduna state.

1. 3 Objectives of the Study.

The purposes and objectives of the study included**:**

1. To determine effect of constructivist teaching strategy and the traditional method on addition and subtraction skills at primary level.

2. Find out effect of addition and subtraction skills between the male experimental group and the female experimental group.

3. To establish any effect on commutative and associative additive properties (Discovery method) between the experimental and control groups.

4. Make comparison between the constructivist teaching strategy and the traditional method.

5. Make recommendation on which of the two strategies enhances the teaching of addition and subtraction skills in primary schools.

1.4 Research Questions.

In this study the following research questions were formulated**:**

1. Is there any significant difference between mean score of experimental and control groups in addition skills?

2. Is there any significant difference between mean score of experimental and control groups in subtraction skills?

3. Is there any significant difference between mean score of experimental and control groups in addition and subtraction skills?

4. Is there any significant difference between mean score of male experimental and female experimental groups in addition and subtraction skills?

5. Is there any significant difference between mean score of experimental and control groups in commutative and associative additive properties?

1. 5 Hypotheses of the Study.

The hypotheses of this study included:

1. There is no significant difference between mean score of experimental and control groups in addition skills.

2. There is no significant difference between mean score of experimental and control groups in subtraction skills.

3. There is no significance difference between mean score of experimental and control groups in addition and subtraction skills.

4. There is no significant difference between mean score of male experimental and female experimental groups in addition and subtraction skills.

5. There is no significant difference between mean score of experimental and control groups in commutative and associative additive skills (Discovery method).

1.6 Significance of the Study.

This research attempted to provide a possible instrument for improving pupils' performance and achievement in addition and subtraction skills. It intended to provide the necessary guide to Model schools in curriculum design at primary school level. It aimed to be of great significance to mathematics educators and other prospective researchers in making recommendations and references. It intended to help pupils develop conceptual and manipulative skills in addition and subtraction skills. It determined to develop a habit of effective critical thinking that will lead to effective and objective thinking by the pupils. This was the basis for developing scientific attitude to the world around them. Furthermore the current research will help pupils to develop the ability to use numbers to find solution to practical problems involving calculation and reckoning in any vocation to which they may be called after school life.

Finally, the significance of the study was to identify, make comparison and determine effects of Tri-constructs teaching strategy and the traditional method on addition and subtraction skills. This was with the view of making recommendations on the method to be adopted in teaching addition and subtraction skills at primary school level.

1.7 Scope and Delimitations of the Study.

The delimitations of the study included**:**

1. The study was restricted to primary three levels of Model Primary Schools.

2. Two Model Primary Schools were selected for the study Kauru central in Kauru L. G. A. and Shehu Idris in Zaria L. G. A.

3. It was restricted to only Model Primary Schools.

4. Restricted to instructional strategies and gender achievement in addition and subtraction skills.

1.8 Summary of the chapter

Mathematics education is established world wide as a major area of study with numerous dedicated journals and conferences serving national and international communities of scholars, Based on this Adetula, highlighted many problems on addition and subtraction skills at primary schools. Such problems include poor performance, achievement, attitude interest etc. One of the objectives or purpose of this study was to determine the effect of constructivist teaching strategy and the traditional method. Also find the statistical difference between mean score of the experimental and control groups. To do this five research questions and hypotheses were formulated to help in finding the empirical answers to the research question raised. The study intended to cover primary three pupils of model primary schools in Kaduna state.

CHAPTER TWO

LITERATURE REVIEW

2.01 Introduction.

This chapter contains a review of related studies on the constructivist theories of teaching and learning of mathematics drawn from past researches on the subject under research. The literature is organized into meaningful subheadings for easy understanding as explained below:

Teaching Mathematics at Primary School in Nigeria

Mathematics is a powerful tool for the development of any nation.

However, the teaching of this subject at all the school levels in Nigeria has not been very impressive. For instance, at the foundation level, that is , at the primary school level the bulk of teaching is on number concepts and the basic operation (addition, subtraction, multiplication and division). These operations are taught with a strong emphasis on drill and practice of number facts, which are often implemented as classroom chorus drills. Clearly, such drills put emphasis on repetition and fixation of procedures or algorithms to the extent of ignoring understanding (Adetula, 1987).

Ojo (1986) enumerated some common but basic problems of mathematics instruction in our school system. These borders on curriculum, attitudes of both teachers and students/pupils towards teaching and learning of mathematics and lack of adequate instructional materials. The ability to add or subtract develops later than many parents and teachers think. Many first graders (class one or six-year olds) are ‘taught’ addition before they can understand it. This results into verbal or rote learning. Piaget therefore advises teachers to pay attention to both the methods of teaching and stages of development of children if true understanding is to occur. It is against this background knowledge that this study is set to discover if the use of construct methods may act as a new strategy for teaching mathematics in primary schools.

History of Constructivist Theory

In past centuries constructivist ideas were not widely valued due to the perception that children’s play was seen as aimless and of little importance. Jean Piaget did not agree with these traditional views, however. He saw play as an important and necessary part of the student’s cognitive development and has provided scientific evidence for his views. Today, constructivist theories are influential throughout much of the so- called informal learning sector. One example is the Investigate Centre at the

Natural History Museum, London. Here visitors can engage in open ended investigations of real natural history specimens reaching towards self selected goals (Ernest, 1991).

According to constructivism, learning is the result of individual mental construction, where by the learner learns by matching new against given information and establishing meaningful connection, rather than by internalizing mere factoids to be regurgitated later on. In constructivist thinking, learning is affected by the context, the belief and attitudes of the learner. Here, learners are given more latitude in becoming effective problem solvers, identifying and evaluating problems, as well as deciphering ways in which to direct their learning to those problems (Brooks and Brooks, 1993}. From the constructivist point of view; how, what, where and when mathematics should be taught plays a major role in discussion.

For example, Byrnes (1996) and Arseneau and Rodenburg (1998) contrast objectivist and constructivist approaches to teaching and learning as:

Objectivist View	Constructivist View
Knowledge exists outside of individuals and can be transferred from teachers to students.	Knowledge has personal meaning. Individual students create it.
Students learn what they hear and	Learners construct their own

what they read. If a teacher explains abstract concepts well, students will learn those concepts.	knowledge by looking for meaning and order; they interpret what they hear, read, and see based on their previous learning and habits. Students who do not have appropriate backgrounds will be unable to accurately "hear" or "see" what is before them.
Learning is successful when students can repeat what was taught.	Learning is successful when students can demonstrate conceptual understanding.

For meaningful teaching/learning to take place, teachers should be up to date with the current reforms in mathematics education.

2.02 Addition and Subtraction Skills

According to Piaget, addition and subtraction are one operation, a reversible one. To find out when children learn the whole remains invariant, regardless of the way its parts are arranged. Piaget used the number 8 in the form of 4 + 4 and 1 + 7. The child was given sweets for two consecutive days. Day one; 4sweets at 11 O'clock and 4 at tea time (1) 0000 + 0000. Day two; 1 sweet at 11 O'clock and 7 at tea time (11) 0 0000000. The child's responds at stage one; (6 or 7 years) is that there was more sweets on day two. In the second stage, he got the answer correctly after some efforts and experiments. At the third stage, the response is immediate. To really understand addition as operation, the child must be able to realize that 1 + 7 can also be expressed as 8 and in reverse, 8 is also 1 + 7, 4 + 4, 3 + 5 etc. This can be done at stage 3 mentally without the counters. For addition and subtraction problems involving renaming or without renaming children should also begin at the concrete level then to expanded notation without concrete materials and finally in conventional notation. Other activities such as trying to make two sets have the same counters by adding to one set what has been subtracted from the other set; that is equalizing two sets of counters using the operations of addition and its inverse subtraction, should be encouraged among the children at this stage.

However, in this study the following skills were hoped to be identified; (i) Knowledge of terms, concepts, generalization and rules of addition and subtraction. (ii) Comprehension that is ability to interprets, transform and translate facts and rules governing addition and subtraction. (iii) Application that is ability to compute, manipulate and solve problems in addition and subtraction. To achieve these a Tri- Constructs Teaching Strategy was adopted as contained in chapter three. The skills taught by this strategy includes, collecting and putting numbers or things together (addition) also reducing and decreasing of numbers or things (subtraction) with help of concrete materials. Understanding grouping of tens and units of numbers and adding or subtracting numbers with or without renaming with the help of Pocket Charts. Also using inductive procedure and trying pair's numbers in the opposite order, the children will be able to arrive at a generalization that the order of adding whole numbers does not change sum. Finally these skills were purely to enhance the pupil's performance in addition and subtraction skills and lead to mastery, application and knowledge of addition and subtraction skills at primary level.

2.03 Concept of Constructivism

In the view of the constructivist, learning is a constructive process in which the learner builds on internal illustration of knowledge, a personal interpretation of experience. Learning is an active process in which meaning is established on the basis of experience {Bednar, Duffy, Perry, 1995}. The fundamental challenge of constructivism is that it changes the locus of control over learning from the teacher .to the student. They claimed that objectives should be negotiated with students based on their own felt needs (Hanckbarth, 1996).

However, to pupils in primary schools their programmed activities should emerge from within the contexts of their lived worlds. Also Piaget said that for every stage in addition and subtraction of numbers, certain activities should precede and be prerequisite for such procedures. These include physical models with practical activities before the corresponding paper and pencil work. This will help to avoid children interchanging addition rules for subtraction and vice versa or placing numerals incorrectly. It will also assist knowledge construction to the pupils. Also students should work together with peers in the social construction of personally significant meaning. Then evaluation should be a personalized ongoing, shared analysis of progress.

The study in the use of human cognition has many specific applications in educational practice and technology. The following are five general educational applications of constructive theory that should be considered when designing methods of instruction. First, if learning depends on how information is mentally processed, then student's cognitive processes should be a major concern to educators. Student's learning difficulties can often be attributed to ineffective or inappropriate cognitive processes (Swanson, 1987).

Second, educators must consider student's levels of cognitive development when planning topics and methods of instruction. For example, explanations based on concrete operational logic are unlikely to be effective ways of presenting ideas in a preoperational kindergarten.

Concrete operational elementary school children have difficulties in understanding abstract ideas that do not tie in with their own experience. These students will learn more effectively if the same information is presented through familiar concrete, examples. Even high school and college students, who have not completed the formal operational stage, will need concrete experience prior to handling abstract materials. Third, students organize the information they learn. Teachers can help students learn by presenting organized information and by helping students see how one thing relates to another. Four, new information is most likely acquired when people can associate it with that they have already acquired. Therefore, teachers should help students learn by showing them how new ideas relate to old ones. When students are unable to relate new information to anything with which they are familiar, learning is likely to be slow and ineffective (Swanson, 1987).

Fifth, B. F. Skinner (1954, 1968) has argued from an operational conditioning perspective that students must actively respond if they are to learn. Cognitivists share that with Skinner; however, they emphasize mental activity rather than physical. If students control their own cognitive processes, it is ultimately the students themselves who decide what information will be learned and how. It is important to note that constructivism does not suggest particular pedagogy. In fact, constructivism describes how learning should happen, regardless of whether learners are using their experiences to understand a lecture or attempting to design a model airplane. In both cases, the theory of constructivism suggests that learners construct knowledge. Constructivism as a description of human cognition is often associated with pedagogic approaches that promote active learning by doing (Perry & Duffy, 1995).

This study has spelt out five clear general educational applications of constructivist theory that should be considered when designing methods of instructions. He has forgotten that learners need other people (teachers) that will guide them in achieving their educational goals. Teachers improvise the necessary teaching materials that will facilitate understanding of the subject matter. The contribution of Piaget is very important in the history of mathematics education.

2.04 The Influence of Piaget's Mental Theory on Mathematics Teaching And Learning.

Piaget's mental theory has a lot of influences on the teaching and learning of mathematics. These are as follows (Adler, 1971).

1. The children should at this stage be made to discover the commutative and the associative properties of addition. Using an inductive procedure and trying pairs of numbers in the opposite order, they should arrive at a

generalization that the order of adding whole numbers does not change the sum. Since the child's mental development advances through qualitatively different stages, these stages should be considered when planning the mathematical experiences of a child at any given age. First, there should be experiences, which he is ready for, in view of the stage of mental growth that the child has attained. On a second note, they should be of help in preparing the child to the next stage. A topic should neither be taught too early or too late. The current mathematics curricula for primary and secondary schools took into consideration the cognitive development of the children. This is why geometry is not introduced in primary one until primary two when the child is ready to absorb such information. Similarly, everyday statistics is not introduced until primary four (4).

2. A child should be tested to ensure that he has mastered all the prerequisites necessary for mastering a mathematical concept before introducing a new mathematical concept. When the child is not ready to learn a concept, he should be provided with the necessary experiences that will help him to be ready to learn the concept. For example, one objective in junior secondary school (jss) algebraic processes is that students will be able to use symbols in simple mathematical statements. The mathematical content, which will be taught so as to achieve this objective, is "use of letters to represent numbers".

3. The child’s thinking is more flexible when it is based on reversible operation. Therefore, mathematics teachers should teach pairs of inverse operations in arithmetic together, for example, addition and subtraction, multiplication and division, proportions and inverse proportions so as to balance each other.

4. At the level of concrete operation, the child has an incomplete grasp or understanding of the relations among the subsets of a set. In order to close this gap, the mathematics teacher should aid the children in exploring by direct observation, different sets and their subsets, unions of sets, as these occur naturally in the learning situation. For example, a set of writing materials in a class will comprise black pens blue pens, red pens, pencils, and pieces of chalk. A group of all these will comprise a union of sets called “set of writing materials.’’ The teacher should guide the children in sorting out different subsets (e.g. a set of black pens, a set of blue pens, a set of pens, a set of pencils etc).

Implications for Teaching Addition and Subtraction

1. The Van-Engen –Steff’s study cited that approximately half of 100 first grades tested did not realize the equality of 3 + 2 and 5. Children begin to learn by trial and error the reversibility of the equals relation; if 3 + 2 = 5, then 5 = 3 + 2 that addition should be taught in a systematic manner only when the reversibility concepts has been developed.

2. Objects that are alike e.g. stones, blocks same color and shape should be used in quantitative grouping or addition of numbers so that qualitative differences (color or shape) do not confuse the basic objective of number relationship.

3. Subtraction, which is often referred to as the inverse of addition has been taught as a joint operation.

4. Regardless the necessity for manipulations of concrete materials, Piaget emphasized that experience is always necessary for intellectual development, hence the child should not see demonstration performed or having something explained, but he should be actually involved in the transformation of things and finding the structure of his own actions on the objects.

5. When the child has undergone all the stages, he is then ready for systematic addition "facts" in an abstract form. They should be made to develop the addition and subtraction facts themselves in a table form.

The primary implications of Piaget's work in general are that for every stage in addition and subtraction of numbers, certain activities should precede and be prerequisite for such procedures. These include physical models with practical activities before the corresponding paper and pencil work. However, Jean Piaget constructed many elaborate mathematical models of the mental structures, which are characteristics of the period of concrete operations and formal operations. These mathematical models of Piaget shed little light on the art of teaching. Despite his contribution the mathematics performance of our pupils is very low. Constructivism and knowledge is an important aspect of this study, which is expected to help the impoverished pupils' mathematical performance.

2.05 Constructivism and Knowledge.

It has been pointed out by Nodding (1990), that constructivism raises serious questions from an epistemological position. What does it mean, for example, to talk of individual construction as 'knowledge'? Nodding gives an example of a student Benny, who had developed a particular process of calculation, which satisfied him. This process could be seen by mathematicians of wider experience than Benny to be inadequate. Is there any sense in which Benny's process could be regarded as knowledge?

An epistemologist is often concerned with the status of knowledge. A constructivist view of knowledge is that it 'fits' experience. If that experience changes, the knowledge may need to be modified. However, Nodding pointed out that learning should be seen as knowledge construction, which the children should use to enhance their learning. Despite this study the performance of the pupils in mathematics remain low. It is the interest of this study to adopt the same strategy to investigate the effect of constructivist teaching strategy on mathematics performance in primary schools. Constructivism and teaching is an important literature to this study.

2.06 Constructivist Perspective on Teaching and Learning of Mathematics.

The traditional methods of teaching mathematics have been contrasted with the constructivist methods, which involve asking students questions to guide them in their learning experience. Innovative teaching requires that teachers discover unique ways of presenting knowledge to the pupils. An example of the constructivist approach is a teacher, which lets her students discover for themselves the concept of measurement and the importance of using a standard unit of measurement. However, the study emphases the use of questions to help pupils discover for themselves concepts and relations that will guide them in their learning. Yet for too long mathematics educators have been using Socratic method of teaching but the performance of pupils in mathematics remain a debating topic.

It has recently become fashionable to talk about constructivism in relation to the teaching and learning of mathematics. If teaching is to lead pupils towards conventional scientific ideas then the teacher's intervention is essential, both by providing appropriate experimental evidence and in king the theoretical ideas and conventions available to pupils. Educating mathematics teachers involved several possible reforms concerning teacher's beliefs, content knowledge, and pedagogical knowledge. Reforms in the education of mathematics teachers are necessary to assist them in acquiring a deeper understanding of the subject. (Manouchehri & Azita. 1997).

2. 07 Constructivist Teaching Methods.

According to Kappan (1996), there is much pedagogy that leverages constructivist theory. Most approaches that have grown from constructivism suggest that learning is accomplished best using a hands-on approach. Learners learn by experimentation, and not by being told what will happen. They are left to make their own inferences, discoveries and conclusions. It also emphasizes that learning is not an "all or nothing" process but that students learn the information that is presented to them by building upon knowledge that they already possess. It is therefore, important that teachers constantly assess the knowledge their students have gained to make sure that the students' perceptions of the new knowledge are what the teacher had intended. Teachers will find that since the students build upon already existing knowledge, when they are called upon to retrieve the new information, they may make errors. It is known as reconstruction error when we fill in the gaps of our understanding with logical, though incorrect, thoughts. Teachers need to catch and try to correct these errors, though it is inevitable that some reconstruction error will continue to occur because of our innate retrieval limitations (Jong Suk Kim, 2005).

However, many constructivist scholars like Jean Piaget (1967), Vygotsky (1978), Brown et al (1989 &1996), McMahon (1997), Burns (1992), Bencze (2005), Crawford (1991) and Kirschner et al (2006) have supported the following constructivist teaching methods**:**

2.07.1 Children Learn By Doing!

A practical approach guiding children to discover facts for themselves is what should be aimed at. Practical work should involve every child in the class. If there is insufficient apparatus for them to use simultaneously the difficulty can sometimes be overcome by dividing the class into groups. If this is done each group should know exactly what it should be doing. Any teacher who has used practical methods will know what a difference it makes to the interest of the children and this alone should encourage performance with this approach.

For example, to add or subtract three digits numbers, sufficient experiences, working out problems with objects such as bottle tops, number blocks, sticks etc at the concrete level should be given before paper and pencil level to avoid children interchanging addition rules for subtraction and vice versa or placing numerals incorrectly. Individual learning is another constructivist teaching technique (Piaget, (1967) & Vygostky, 1978).

2.07.2 Individualized Learning

According to McMahon (1997) & Wertsch (1999), individual method should take a large place in the teaching of mathematics, especially in infant classes. The background of the children in all classes will be varied. Some will have learned to recite numbers from parents or older brothers and sisters. They will have no idea of the meaning of the name of the values. On the other hand there will be children who have been to a nursery school and done elementary work. And there will be those who have had very little help towards schoolwork of any kind. In general the children will have been used to doing things on their own rather than in large groups. For individual work, individual apparatus is needed and children learn from the activities planned for them.

For example, individual work, individual apparatus is needed and children work at their own rate and memorize the facts from the activities planned for them. For example, if the child has been taught the symbols for the numbers 0 to5 the kind of apparatus could be: (a) An egg box and seeds with the numerals 0, 1, 2, 3, 4 and 5 painted in the holes. The pupils can count the appropriate number of seeds and put them in the right place. (b) A set of cards cut to form puzzles. The pupils using these will match the symbols to the number of dots. If they get them correct the pieces will fit. Group learning also facilitate teamwork and understanding of the learning experiences.

2.07.3 Grouped Learning

To Brown et al (1989) this term is used to describe two different ideas. The stage and rate of progress of pupils will vary. Some work can be taught more successfully if the class is divided into groups, rather than being taught as a whole. The teacher using this method will explain a new step in their work to one group while the other works at set activities. The number of groups will depend very much on the particular class. Two or three groups may be sufficient to ensure that every child is doing work of a suitable standard for his particular needs. In some classes dividing children into small groups of six to eight will be the most effective way. It is important that each child knows what he is expected to .do and has the necessary apparatus to get on with it on his own.

For example a variety of activities can be prepared for the class and the pupils grouped to take turns in using the different sets of apparatus. In this way the children are able to gain from a wider variety of activities than if they are all doing the same thing at the same time. Discovery method is another aspect of constructivist teaching method (Wertsch, 1997).

2.07.4 Learners Need for Discovery Method.

Piaget (1967) believes that children can be helped to think about how to solve a problem for them. They should not be given formulae to use without knowing where they come from. In other words the pupils do the discovering. The teacher guides their discussion and gives them suitable apparatus to direct them to find out the particular rule or method to be learned. To a certain extent this method can be applied to most of the topics that are taught to primary school pupils. For example, children should be made at this stage to discover the commutative and associative properties of addition. Using an inductive procedure and trying pairs of numbers in the opposite order, they should arrive at a generalization that the order of adding whole numbers does not change the sum. The questioning technique is anther form of constructivist teaching method (Crawford, 1991).

2.07.5 Learners Need for Questioning Technique!

Kappan (1996) if a person is asked a question his response is different from when he is told facts or information. A teacher must help his pupils to think about the work that is being taught and not just to accept facts and statements that are made. Teaching and lecturing are different. A lecturer prepares what he has to say and will often not know if his students understand or follow what he is teaching. One of the most important qualities of a teacher is to be able to judge whether his class is following what is being taught. There is very little that a teacher needs to tell his pupil in mathematics. By the careful use of questions he can guide them to think out what is needed. By putting the situation before them to be discussed or examined they will learn and understand as they learn. A good teacher can keep a class interested with all their minds active by the careful use of questions. A good general rule for all teachers is that they should ask rather than tell pupils while they teacher. Questions are also asked to enable the mathematics teacher discover students misconceptions or common errors and difficulties with a view to remedying them.

For example, consider the topic lengths of arcs of circles. The common errors include mistaking the diameter for the radius or radius for diameter, and mistaking the formula of circumference as formula for area of circle or vice versa. Learners need teachers as instructors for guiding the learning process (Kirschner et al, 2006).

2.07.6 Learners Need for Other People (Teachers).

To Bencze (2005) when new work is introduced to pupils it must be done in such a way that they can understand what they are learning. Activities should be organized to help pupils to think out results for themselves. For example, in the infant classes children must learn the place value of figures. If the pupils tie matchsticks together it will help their understanding. If they replace ten counters from the unit rod of an abacus with one on the tens rod, the pupils will learn and remember the comparative values. With older pupils topics such as weight, capacity, area and volume should be approached practically. It must be realized that individual pupils should take part in the practical activities. Pupils may not know, even if they have access to ideas and an urge to change, how to altar their thinking. They may lack the skills necessary to share their ideas. They may not know how to think about their own ideas, how to learn new ones or how to decide what to believe. Therefore, as with conceptual change, students need others (often teachers) to introduce them to new ideas.

Pupils cannot change their thinking on their own, even if they want to; they lack the understanding of what laws, theories and inventions are available to them. For pupils to learn, therefore, experience alone is not enough; they need to learn the different laws and theories, which guide their ideas. Teachers must, therefore, take purposeful steps to get pupils to see things in new ways. Knowledge is becoming communally based; moreover, learners need access to the knowledge of different communities. Learning should not be so conservative as to ignore the knowledge and ways of different races, cultures and societies. Learning must be pluralist rather than conformist.

For example, according to Bencze while a teacher can show to students on a blackboard that various atoms can be rearranged to make new molecules in a chemical change; students often need to try such reactions with concrete materials before they fully understand the new ideas, skills etc. Teachers must, therefore, take purposeful steps to get students or pupils to see things in the new ways. For example, it would be about getting students to "see" particular images in the black-and-white photograph. It is also getting pupils to know the formula of circles and how it can be applied to solve related problems on area of a circle. Learners need first hand information to help them in their learning experiences.

2.07.7 Learners Need for First-Hand Experiences!

According to Bencze (2006) pupils need to use and test ideas, skills, through relevant activities. This involves a concrete experience of the abstract ideas that have been presented to the learners. Finally, learning does not mean simply receiving and remembering a transmitted message;

instead educational research must offer compelling evidence that students learn mathematics well only when they have constructed their own mathematical understanding. Assessment is very important in all learning experiences.

2.08 The Concept of Assessment.

According to Holt & Willard-Holt (2000) emphasizes the concept of dynamic assessment, which is a way of assessing the true potential of learners that differs significantly from conventional tests. Here the essentially interactive nature of learning is extended to the process of assessment. Rather than viewing assessment as a process carried out by one person, such as an instructor, it is seen as a two-way process involving interaction between both instructor and learner. The role of the assessor becomes one of entering into dialogue with the persons being assessed to find out their current level of performance on any task and sharing with them possible ways in which that performance might be improved on a subsequent occasion. Thus, assessment and learning are seen as inextricably linked and not separate processes

According to this viewpoint instruction should see assessment as a continuous and interactive process that measures the achievement of the learner, the quality of the learning experience and courseware. The feedback created by the assessment process serves as a direct foundation for further development. The structures of the learning experiences help in conceptual understanding.

2.08.1 The Structuredness of the Learning Process

Savery (1994) contends that the more structured learning environment, the harder it is for the learners to construct meaning based on their conceptual understanding. A facilitator should structure the learning experience just enough to make sure that the student get clear guidance and parameters within which to achieve the learning objectives. Yet the learning experience should be open and free enough to allow for the learners to discover, enjoy, interact and arrive at their own, socially verified version of truth.

Where the sequencing of subject matter is concerned, it is the constructivist viewpoint that the foundation of any subject may be taught to anybody at any stage in some form (Duffy & Jonassen 1992). This means that instructors should first introduce the basic ideas that give life and form to any topic or subject area, and then revisit and build upon these repeatedly. This notion has been extensively used in curricula.

It is also important for instructors to realize that although a curriculum may be set down for them, it inevitably becomes shaped by them in to something personal which reflects their own belief systems, their thoughts and feelings about both the content of their instruction and their learners (Rhodes & Bellamy 1999). Thus, the learning experience becomes a shared enterprise. The emotions and life contexts of those involved in the learning process must therefore be considered as an integral part of learning. The goal of the learner is central in considering what is learned (Brown et al. 1989; Ackerman 1996).

It is important to achieve the right balance between the degree of structure and flexibility that is built into the learning process. A constructivist learning intervention is thus an intervention where contextualized activities (tasks) are used to provide learners with an opportunity to discover and collaboratively construct meaning as the intervention unfold. Learners are unique individual, and instructors act as facilitators rather than as teachers. Motivation for learning emphasizes the importance of the learner being more active.

2.09 The Motivation for Learning

Von Glassersfeld (1989) argued that the responsibility of learning should reside increasingly with the learner. Social constructivism thus emphasizes the importance of the learner being actively involved in the learning process, unlike previous educational viewpoints where the responsibility rested with the instructor to teach and where the learner played a passive, receptive role. Von Glasersfeld emphasizes that learners construct their own understanding and they do not simply mirror and reflect what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information. Another crucial assumption regarding the nature the learner concerns the level and source of motivation for learning.

According to Von Glasersfeld, sustaining motivation to learn is strongly dependent on the learner's confidence in his or her potential for learning. These feelings of competence and belief in potential to solve new problems are derived from first-hand experience of mastery of problems in the past and are much more powerful than any external acknowledgement and motivation (Prawat & Floden 1994). This links up with Vygotsky's "zone of proximal development" (Vygotsky 1978) where learners are challenged within close proximity to, yet slightly above, their current level of development. By experiencing the successful completion of challenging tasks, learners gain confidence and motivation to embark on more complex challenges. The role of the instructor is very important in the learning process.

2.10 The Role of the Instructor.

According to the social constructivist approach, instructors have to adapt to the role of facilitators and not teachers. Where a teacher gives a didactic lecture which covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. In the former scenario the learner plays a passive role and in the latter scenario the learner plays an active role in the learning process. The emphasis thus turns away from the instructor and the content, and towards the learner. This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher (Brownstein 2001). A teacher tells, a facilitator asks; a teacher lectures from the front, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions; a teacher mostly gives a monologue, a facilitator is in continuous dialogue with the learners (Rhodes & Bellamy, 1999). A facilitator should also be able to adapt the learning experience 'in mid-air' by using his or her own initiative in order to steer the learning experience to where the learners want to create value. Learning principles propel learning process (Bauersfeld, 1995).

2.11 Constructivist Teaching And Learning Principles.

According to Bencze (2005) constructivist-learning theory suggests a number of points about teaching and learning:

a. Learners have ideas!

b. Learner's ideas often contradict those of teachers!

c. Learner need 'first hand' experience!

d. Students and scientist' inquires are self-fulfilling!

e. Learners like their ideas!

f. Learners see what they want to see!

g. Learners nee d other people!

h. Students need to know how to learn!

I. Learners often are not aware of what they know!

j. Learners may not discover experts 'conclusion'!

k. Students deserve the right to determine their beliefs!

Perhaps students deserve the right to determine their own beliefs in school setting and beyond (Bencze, 2005). However, this study has succeeded in explaining the constructivist teaching principles to be used at all levels of education. Yet the performance and achievements of pupils in mathematics is poor.

2.12 The Socio-Cultural Context of Classroom.

Crawford (1994) believes that in order to consider meaningful teaching and learning in mathematics classroom for students, both individually and collectively, we have to recognize its dependence on individual experience and socio-cultural practices. This is the subject of an area of study known as Activity theory. Activity theory "describes the process through which knowledge is constructed as a result of personal (and subjective) experience of an activity". Cobb, Perlwitz, & Underwood, 1991, explore the relationship between constructivist approaches to mathematics teaching and social -cultural norms in mathematics classroom.

Socio-cultural theories view learning as integration into a community of practice in which social actions are identified and classroom activities designed. They also suggest "the teacher's role in these activities is to forge the last link in the chain by ensuring that children execute the specified social actions that make it possible for them to isolate ideal mathematical forms when they solve tasks'. Thus the interactions of children in classroom activities are a small part of their enculturation into the required social actions.

2.12.1 How Pupils Learn Mathematics?

According to Burns (1992) not only is it important to consider the content of the mathematics curriculum; it is also significant to know about how people learn mathematics. Students need to learn mathematical concepts and see relationships among them. Because concept and relationships are constructed by people and exist only in their minds, to learn mathematics, children must construct these concepts and relationships in their own minds. This theory describes two important components of learning and teaching mathematics: helping students to develop relational understanding and to construct knowledge and mathematical concepts (John Van De Walle, 1995).

These theories focus on how students develop relational understanding and construct knowledge. The weakness of these theories failed to understand that most today's teaching and learning of mathematics is not practically oriented. This is because most teachers use obsolete method of teaching. Therefore, the interest and attitude of pupils are not aroused. This can be understood by some researches on mathematics performance advocated by some researchers.

2.13 Researches on Mathematics Performance.

Bali (1989) in a study of students' performance in mathematics essay and objective type questions found that there were no significant differences between the performances of boys and girls in both essay questions. This study is an attempt to explore further areas of primary mathematics, which can be tutored by means of, constructs method.

Akpan (1988) investigated the relationship between performance in mathematical problem solving and affective behaviors among secondary school students. Findings from the study identified that relationship between general creative behaviors and the criterion variable was not statistically significant. While Osafemi (1984) have shown empirically that attitude toward mathematics is an important factor in mathematics achievement. Investigations relating mathematics performance to students' attitudes toward mathematics have produced varied results. In another finding he reported relatively low correlation of 0.11 between creativity and arithmetic performance.

Unfortunately, according to Lassa (1984) the teaching and learning of mathematics is in a sorry state. Most often, the students are subjected to rote learning without any practical demonstration or arousal of interest in the topic. Therefore, it is the hope of this study to explore different strategies that will motivate both pupils and teachers in constructivist teaching of mathematics. The evidence supporting constructivism and teaching is of paramount importance to this study.

2.14 Review of the Related Studies

Hmlo-Silvee, Duncan, & Chinn (2007) cite several studies supporting the success of the constructivist problem-based and inquiry learning methods. For example, they describe a project called GenScope, an inquiry-based science software application. Students using the genScope software showed significant gains over the control groups, with the largest gains shown in students from basic courses. Hmelo-Silver et al also cited large study by Geier on the effectiveness of inquiry-based science for middle school students, as demonstrated by their performance on high-stakes standardized tests. The improvement was 14% for the first cohort of students and 13% for the second cohort. This study also found that inquiry- based teaching methods greatly reduced the achievement gap for African-American students.

Guthrie et al (2004) compared three instructional methods for third-grade reading: a traditional approach, a strategies instruction only approach, and an approach with strategies instruction and constructivist motivation techniques including student choices, collaboration, and hands-on activities. The constructivist approach, called CORI (Concept-Oriented Reading Instruction), resulted in better student reading comprehension, cognitive strategies, and motivation.

Jong Suk Kim (2005) found that using constructivist-teaching methods for 6^{th} grades resulted in better student achievement than traditional teaching methods. This study also found that students preferred constructivist methods than traditional ones. However, Kim did not find any difference in student self- concept or learning strategies between those taught by constructivist or traditional methods.

Dogru & Kalender (2007) compared science classrooms using traditional teacher-centered approaches to those using student-centered, constructivist methods. In their initial test of student performance immediately following the lessons, they found no significant difference between traditional and constructivist methods. However, in the follow-up assessment 15 days later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods. However, every coin has two sides; the constructivist teaching has been criticized by some educational constructivism.

2.15 Criticism of Educational Constructivism.

A group of cognitive scientist has questioned the central claims of constructivism, saying that they are either misleading or contradict known findings. Another source attempts to sketch the influence of constructivism in current mathematics and science education, aiming to indicate how pervasive Aristotle's empiricist epistemology is within it and what problems constructivist faces on that account.

Cognitive scientists are not the only ones questioning Constructivism. Other educators are also beginning to question the effectiveness of this approach toward instructional design, especially as it applies to the development of instruction for novices (Mayer, 2004; Kirschner, Sweller, & Clark, 2006). While some constructivist argue that "learning by doing" enhances learning, critics of constructivism have argued that little empirical evidence exist to support this statement given novice learners Mayer, 2004.

Sweller and his colleagues argue that novices do not possess the underlying mental models or "schemas" necessary for "learning by doing" e.g. Sweller, 1988. Indeed, Mayer (2004) even suggests that fifty years of empirical data do not support using the constructivist teaching technique of pure discovery; in those situations requiring discovery, he argues for the use of guided discovery instead.

While constructivism has great popularity as a philosophy of learning, that doesn't mean that all teaching techniques based on constructivism are efficient or effective for all learners. Mayer (2004) suggests many educators misapply constructivism to use teaching techniques that require learners to be behaviorally active. He describes this inappropriate use of constructivism as the "Constructivist teaching fallacy."

Kirschner, et al (2006) describes constructivist-teaching methods as "unguided methods of instruction." They suggest more structured learning activities for learners with little to no prior knowledge. Perhaps because of this proposition the Kirchner, et al (2006) article has been criticized by a number of authors for various reasons.

However, it is important to know that constructivist teaching\learning intervention is thus an intervention where contextualized activities are used to provide learners with an opportunity to discover and collaboratively construct meaning as the intervention unfolds. Learners are respected as unique individuals, and instructors act as facilitators rather than as teachers.

2.16 Implication of the Review of the Related Studies.

From the review of the related studies it is important to note that constructivism describes how learning should happen, regardless of whether learners are using their experiences to understand a lecture or attempting to design a model airplane. In both cases, the theory of constructivism suggests that learners construct knowledge. Constructivism as a description of human cognition is often associated with pedagogic approaches that promote active learning by doing. It is of paramount importance to note that the central concern of constructivism is changing the locus of control of teaching and learning from the teacher to the learner. This idea was supported by a number of researches and evidence supporting constructivism. For example, Hmelo-Silver et al (2007) they describe a project called GenScope, an inquiry-based science software application. Their findings showed that students using the GenScope software showed significant gains over the control groups with the largest gains shown in students from basic courses.

Guthrie et al (2007) used constructivist approach called CORI (Concept-Oriented Reading Instruction) resulted in better student reading comprehension, cognitive strategies and motivation. More, Kim et al (2005) did not find any difference in student self- concept or learning strategies between those taught with traditional methods or constructivist.

Also Kalendar et al (2007) compared science classroom using traditional teacher-centered approaches to those using student-centered, constructivist methods. They found no significant difference between traditional and constructivist methods. However, in the follow-up assessment 15 days later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods.

In view of the implications above, it showed that their findings are inconclusive. Therefore, it is the interest of this study to use the constructivist techniques to find the effects of constructivist teaching strategy on primary school mathematics performance. This is with the solid aim of making constructivist contributions and recommendations on the teaching strategy that should be used in teaching primary school mathematics.

2.17 Summary of the chapter

This chapter has reviewed many related studies on constructivist theories of teaching and learning of mathematics drawn from constructivist scholars. Some of them include: constructivist theories; which spelt out five clear general educational applications of constructivist. The influence of Piaget's mental theory on mathematics teaching and learning; this constructed many mathematical models of the mental structures which are characteristics of the period of concrete operation and formal operations. Constructivist perspective on teaching and learning mathematics and constructivist teaching methods; this supported many teaching methods as explained in the related studies. Assessment; this explained the concept of dynamic assessment. The constructivist teaching and learning principles has been explained. The socio-cultural context of classroom made emphasis on the interaction of children in classroom. How do pupils learn mathematics and teaching developmentally were discussed? Review of related studies on mathematics performance were enumerated and explained. Researches and evidence supporting constructivism and the criticism of educational constructivism were also explained. The implications of the related studies were also highlighted.

The basic aim of this review was to facilitate the researcher to obtain meaningful information on the subject matter. This will make the contribution of the study more realistic and constructive.

CHAPTER THREE

METHODOLOGY

3.01 Introduction.

The focus of this chapter was under the following headings, research design, population of the study, sample and sampling technique, instrumentation, research procedure, pilot study, validity and reliability of the test items, treatments and methods of data analysis.

3.02 Research Design.

The design adopted for this study was the Pretest and Posttest control group. It involved the collection of data by the use of level 1 achievement test and level 2 achievement tests. The level 1 achievement test was set to confirm the homogeneity of both the control and the experimental groups. In view of this, the test items were randomly handpicked from "Understanding of Mathematics for Nigeria Textbook 3, New Edition" (Maria, Revised Edition 2000). The design was symbolized below:

O1- X - O2, (Experimental group)

O1 - O2, (Control group)

Experimental Group received Tri-constructs as treatment X and after given level 2 achievement test O2. Control Group received the level 1 achievement test and subjected to achievement test. The level 2 achievement test given to the two groups was the same.

3.03 Population of the Study

The population of this study consisted of 7669 primary three pupils admitted in 2007 session in Model primary schools of Kaduna state. These schools were each located in the local government areas of the state but Kaduna north has two such schools. Though these schools were physically different in terms of location but they same in terms of administration, staffing, fund allocation, infrastructure etc, see table 3.1.

Table 3.1: Population of the Study

SN	MODEL	SCHOOLS	M	F	T	%
1	Birnin Gwari	LGEA Bagoma	38	20	58	0.76
2	Chikun	Kujama 1	52	26	78	1.02
3	Giwa	Giwa Central	311	156	467	6.09
4	Igabi	Mallam Jalo	300	139	439	5.72
5	Ikara	Ikara Central	404	191	599	7.81
6	Jaba	Mallam Maude	128	58	186	2.43
7	Jema'a	Mailafiya 1	136	63	199	2.59
8	Kachia	Kachia 1	349	170	519	6.77
9	Kaduna North	Ung. Rimi Lowcost	275	132	407	5.31
10	Kaduna North	Resarch Kawo	100	50	150	1.96
11	Kaduna South	Shiek Gumi	281	117	398	5.19
12	Kagarko	Kagarko Central	114	52	166	2.16
13	Kajuru	K/Magani 1	235	118	353	4.60
14	Kaura	Tagwai Manchock	232	116	348	4.54
15	Kauru	Kauru central	110	51	161	2.10
16	Kubau	Anchau Takalafia	169	57	226	2.95
17	Kudan	Kudan Central	258	127	385	5.02
18	Lere	Lere Central	334	158	492	6.42
19	Makarfi	Sada	134	59	193	2.52
20	Sabon-Gari	Saidu	443	263	706	9.21
21	Sanga	Gwantu Central	107	57	164	2.14
22	Soba	Soba Central	294	120	414	5.40
23	Zongo-Kataf	Zonkwa v.	70	30	100	1.30
24	Zaria	Shehu Idris	303	158	461	6.01
		TOTAL:	5181	2488	7669	100%

Source: KSUBEB, 2007.

3.04 Sample and Sampling Technique.

This study used the stratified random sampling technique to obtain its sample size. Considering that the research design adopted in this study was the pretest and posttest control group. Two boys were asked to handpick a piece of paper already folded with the names of the model schools from a basket. As a result of this, Kauru central and Shehu Idris model schools were randomly selected as control and experimental groups respectively. The sample size was randomly selected before the commencement of the level 2 achievement test. In both the schools, 20 males and 20 females were randomly selected through picking a ticked piece of paper. Also the researcher was cautious to see that only the selected pupils were allowed in the test. This helped the researcher to control all the intervening variables so as to have good result. The sample size involved 80 pupils, see table 3.2.

Table 3.2: Sample Size.

S\NO	MODEL	SCCHOOLS	SAMPLE	
			MALE	FEMALE
1.	Kauru	Kauru Central	20	20
2.	Zaria	Shehu Idris	20	20
		TOTAL	40	40
		GRAND TOTAL	80	

3.05 Instrumentation.

The instruments used for this study included the level 1 achievement test and the level 2 achievement tests.

3.05.1 Level. 1 Achievement Test

A level 1 achievement test was designed and administered to both control and experimental groups by the researcher. It was set to confirm the homogeneity of the control and experimental groups. Despite difference in physical location of the experimental and control groups it was observed that the two groups were not significantly different. This was subjected to further findings by level 2 achievement test. In view of this, the test items for level 1 achievement test were randomly selected from the "Understanding of Mathematics for Nigeria Textbook 3, New Edition" (Maria Revised Edition 2000) and teachers note of lesson (See Appendix B). The face validity, grammatical construction and possible bias in the test items were validated by mathematics-educators in (ABU, Zaria).

To test the reliability and the validity of the test items, a Test - Retest reliability was observed. Pearson Correlation Coefficient was employed to estimate the reliability and content validity coefficients and was found to be 0.84 and 0.53 respectively.

3.05.2 Level. 2 Achievement Test.

A level 2 achievement test that will help the researcher obtained the necessary data to be interpreted; analyzed and generalized the research's intention was designed by the researcher. This test was administered to both experimental group and the control group. The data obtained from the test was subjected for further analysis in order to answer the research question or hypotheses raised from the research intention. It was divided into three sections (concrete materials, expanded notation without concrete materials and conventional notation). However, Jahun (1988) cited Ebel (1979) recommends that a good test is the one that set explicit specifications which includes:

- Forms of test items to be used.
- Number of items of each form.
- Kinds of task the items will present.
- Number of tasks for each kind.
- Areas of content to be sampled.
- Number of items in each area.
- Level and distribution of item difficulty, see Appendix C.

3.06 Validity and Reliability of the Test Items

The face validity of the level 2 achievement test items was achieved by subjecting it to mathematics-educators in Ahmadu Bello University, Zaria.

To test the reliability and validity of the test items a test – retest reliability was observed and Pearson Correlation Coefficient was used to estimate the reliability and found to be 0.83 while the content validity coefficient was found to be 0.62. This vindicated that the test items were reliable and significant to the study.

3.07 Treatments

The Traditional method of teaching and the Tri-constructs strategy were observed as treatments in the study.

3.07.1 Traditional Methods of Teaching

The traditional method of teaching was purely designed to add or subtract numbers with or without renaming with the help of abacus. Addition and subtraction of numbers that involves renaming was introduced through grouping of numbers e.g. 1111 = 1000 + 100 + 10 + 1. Large numbers were given for addition and subtraction without abacus. Word problems were also given. Therefore, the traditional method does not start its strategy at concrete stage, expanded notation without the concrete materials and finally to conventional notation. The content of the subject matter covered by the groups led to the formation of level 1 achievement test. For the content and pedagogy of the traditional method of teaching addition and subtraction skills see Appendix D. Also New Primary 3 School Modules, (FGN, 1985, P.104-107) provided the topics, see Appendix A.

3.07.2 Tri-Const (Constructivist Teaching Strategy).

This strategy was the postulated Piaget Constructivist teaching strategy for addition and subtraction skills. Unlike the traditional method or aptitude test, the Tri-constructs teaching strategy has doctored a special step adopted for teaching of addition and subtraction with renaming. It tailored the teaching of addition and subtraction skills from concrete steps to expanded notation without concrete materials and finally to conventional step. It is the treatment X (constructivist teaching strategy) that was given to the experimental group only. It was divided into three sections:

1. Concrete Materials.

At this stage, the strategy was designed as an introduction to stimulate the children's interest. The exercises were generally constructs in nature that is children used concrete materials to add or subtract numbers as propounded by Piaget. This is with the solid aim of making the teaching of addition and subtraction skills more realistic and interesting. The children were expected to construct or draw whatever is asked using free hand.

2. Expanded Notation without Concrete Materials

The idea under this strategy was introduced to the children to learn, to group tens and units' procedures. The questions under this stage were tailored toward understanding the place value of figures.

3. Conventional Notation.

At this strategy, learning conventional addition and subtraction of numbers with or without renaming a tri- construct chart called pocket chart was introduced. Children are expected to use the same chart in doing exercises. A tri-construct strategy using shapes and pairs of numbers in the opposite order was introduced. It is aimed at making the teaching of commutative and associative additive properties easier. It also aimed at arriving at a generalization that the order of adding whole numbers does not change the sum, see Appendix E.

3.08 Research Procedure.

To investigate the effects of constructivist teaching strategy on addition and subtraction skills, a period of 8 weeks tri- constructs teaching and administration of achievement test was used. In similar study to investigate the relationship between the effects of computer assisted instruction on mathematics achievement Mairiga (1999) used eight (8) weeks. Similarly to study the relationship between problem solving and computation for 7th Grade low achievers, Noone (1979) used two months duration.

3.09 Pilot Study.

The Tri-Constructs teaching strategy was adopted on addition and subtraction skills by the researcher to the forty (40) randomly selected primary three (3) pupils of Nuhu Bamalli Polytechnic Staff School in Zaria. The teaching was observed for a period of eight (8) weeks at the end of 2006/07. Hence the pilot study was conducted among pupils who were taught Tri-constructs teaching strategy in addition and subtraction skills only. The level 2 achievement test was administered to the pupils selected for the pilot study and their scores marked out of 50 marks were as shown in table 3.3. Using the Pearson Correlation coefficient, the reliability of the test items was found to be 0.83 while the content validity coefficient of the test items was found to be 0.62. The pilot study was meant to test the validity and the reliability of the test items. It was also meant to test the pupils' comprehension, mastery and application of the test items.

Table 3.3: Scores for the Pilot study conducted in NBPZ Staff school

Class- interval	F
20-25	3
26-31	9
32-37	7
38-43	17
44-49	4

3.10 Method of Data Analysis.

In finding the answers to the hypotheses, appropriate statistical tests were used. The statistical package used was the Statistical Package for Social Sciences (SPSS). The statistical test that was employed to analyze the data was the Independent Sample Test. It was employed because of the nature of the data collected and it is one of the statistical tools that will express the mean difference of two independent distributions. The test was calculated based on alpha value of ($\alpha = 0.05$) level of significance.

3.11 Summary of the chapter.

This chapter was discussed under the following headings. The research design employed was the use of pretest and posttest control group. The study used a population of 7669 pupils of model primary schools in Kaduna state. The level 1 achievement test was set to find the homogeneity of the two groups while the level 2 achievement test was meant to provide data for statistical analyses. A total of 80 data was collected and analyzed by the Independent Samples Test. The research procedure covered 8 weeks as observed by many scholars. A pilot study was conducted in NBPZ staff school with 50 pupils and the validity and reliability of the test items were found to be significant to the study. The traditional method of teaching was observed through abacus and word problems with little emphases on renaming. While the Tri-constructs teaching strategy was observed through three stages that is concrete, expanded notation without the concrete materials and finally conventional notation. The traditional and tri-constructs tests were used as treatments.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction:

This chapter presented results and interpretation of the analyses of the data. It was presented under the following headings, data presentation, answers to research questions, test of research hypotheses, summary of findings, discussion of results and summary of the chapter.

4.2 Data Presentation.

The study was conducted on primary three pupils of Model Schools with a sample size of 80. Shehu central primary school was an experimental group and Kauru central primary school as the control group. Each of the groups comprised 20 males and females respectively. The groups were given (30) item level 2 achievement test, which was marked out of 90 marks. The level 2 achievement test was meant to determine the effect of the treatment (Tri-constructs teaching strategy). Data were obtained from the level 2 achievement test and detailed results were shown according to each research question formulated and research hypothesis tested.

4.3 Analysis of Research Hypotheses.

This unit presented each of the five research question and null hypotheses with their corresponding independent sample test for observations. Thus:

Research Question 1: Is there any significant difference between mean score of the experimental and control groups in addition skills? In order to answer this question, table 4.01 provided the data while table 4.02 gave a summary of the results.

Table 4.01: Scores for the experimental and control groups in level 2 Achievement test

Class – interval	EGF	CGF
37-39	0	6
40-42	11	12
43-45	8	9
46-48	16	10
49-51	5	3

Key:

EGF: Experimental Group Frequency

CGF: Control Group Frequency

Table 4.02: Means and Standard Deviations for the experimental and control groups in level 2 Achievement test

Variable	N	Mean	SD
Exptlgroup	40	45.03	3.17
Contlgroup	40	43.25	3.48

From table 4.02, the mean score of the experimental group was 45.03 and a standard deviation of 3.17. While the mean score for the control group was 43.25 and a standard deviation of 3.48. This proved that the experimental group had mean score more than the control group. This implied that the effects of the treatment have impact on the experimental group. However, it is not enough to generalize the research intentions from the results of the research question. The significant test was carried out by means of the research hypothesis.

Null Hypothesis 1: There is no significant difference between mean score of the experimental and control groups in addition skills. In order to analyze the hypothesis 1 above, table 4.03 below gave the summary of the analysis.

Table 4.03: Independent Sample Test of Difference between means of experimental group and control groups in level 2 Achievement test.

Variable	N	Mean	SD	DF	SE	T-cal	T-crit	P-value
ExptlGroup	40	45.03	3.17	78	0.74	2.38	1.99	0.02
Contl group	40	43.25	3.48		0.74			

From the table above, there were equal numbers of 40 pupils under both the experimental and control groups. Their mean score and standard deviation were 45.03, 43.25, 3.17 and 3.48 respectively. Also the T-calculated was 2.38 while the T-critical is 1.99 and the probability (p) value was p=0.02. However, from the on going analysis, the T-calculated was greater than the T-critical (T-cal > T-crit) while the probability value is less than the alpha value α= 0.05 i.e. ($p=0.02 < \alpha=0.05$) adapted in this study.

Therefore, the results of the analysis suggested that the difference between the mean achievement of the experimental group and control groups was statistically significant. We then conclude that there was significant difference between the mean achievements of the experimental group and control group in addition skills. Any differences observed are such that they could have arisen from sampling errors. The information relevant to the analysis is presented in table 4.03.

Research Question 2: Is there any significant difference between mean score of the experimental and control groups in subtraction skills? In order to answer this question table 4.04 provided the data while table 4.05 gave a summary of the results.

Table 4.04 Scores for the experimental and control groups in level 2 Achievement test

Class- interval	EGF	CGF
37-39	8	6
40-42	7	19
43-45	8	7
46-48	10	6
49-51	7	2

Key:

EGF: Experimental Group Frequency

CGF: Control Group Frequency

Table 4.05: Means and Standard Deviations of the experimental and control groups in level 2 Achievement test

Variable	N	Mean	SD
Exptlgroup	40	44.18	3.75
Contlgroup	40	42.30	3.39

From table 4.05, the mean score of the experimental group was 44.18 and a standard deviation of 3.75. While the mean score for the control group was 42.30 and a standard deviation of 3.39. This proved that the experimental group had mean score more than the control group. This implied that the effects of the treatment have impact on the experimental group. However, it is not enough to generalize the research intentions from the results of the research question. The significant test was carried out by means of the research hypothesis.

Null Hypothesis 2: There is no significant difference between mean score of the experimental and control groups in subtraction skills. In order to analyze the hypothesis 2 above, table 4.06 below gave the summary of the analysis.

Table 4.06: Independent Sample Test of Difference between means of experimental group and control groups in level 2 Achievement test

Variable	N	Mean	SD	DF	SE	T-cal	T-crit	P-value
ExptlGroup	40	44.18	3.75	78	0.80	2.34	1.99	0.02
Contl group	40	42.30	3.39		0.80			

From the table above, there were equal numbers of 40 pupils under both the experimental and control groups. Their mean score and standard deviation were 44.18, 42.30, 3.75 and 3.39 respectively. Also the T-calculated was

2.34 while the T-critical is 1.99 and the probability (p) value was p=0.02. However, from the on going analysis, the T-calculated was greater than the T-critical (T-cal > T-crit) while the probability value is less than the alpha value $\alpha = 0.05$ i.e. ($p=0.02 < \alpha = 0.05$) adapted in this study.

Therefore, the results of the analysis suggested that the difference between the mean achievement of the experimental group and control groups was statistically significant. We then conclude that there was significant difference between the mean achievements of the experimental group and control group in subtraction skills. Any differences observed are such that they could have arisen from sampling errors. The information relevant to the analysis is presented in table 4.06.

Research Question 3: Is there any significant difference between mean score of the experimental and control groups in addition and subtraction skills? In order to answer this question table 4.07 provided the data while table 4.08 gave a summary of the results.

Table 4.07 Scores for the experimental and control groups in level 2 Achievement test

Class- interval	EGF	CGF
37-39	0	6
40-42	5	11
43-45	9	10
46-48	21	10
49-51	5	3

Key:

EGF: Experimental Group Frequency

CGF: Control Group Frequency

Table 4.08: Means and Standard Deviations of the experimental and control groups in level 2 Achievement test

Variable	N	Mean	SD
Exptlgroup	40	45.85	3.01
Contlgroup	40	42.58	4.36

From table 4.08, the mean score of the experimental group was 45.85 and a standard deviation of 3.01 while the mean score for the control group was 42.58 and a standard deviation of 4.36. This proved that the experimental group had mean score more than the control group. This implied that the effects of the treatment have impact on the experimental group. However, it is not enough to generalize the research intentions from the results of the research question. The significant test was carried out by means of the research hypothesis.

Null Hypothesis 3: There is no significant difference between mean score of the experimental and control groups in addition and subtraction skills. In order to analyze the hypothesis 3 above, table 4.09 below gave the summary of the analysis.

Table 4.09: Independent Sample Test of Difference between means of experimental group and control groups in level 2 Achievement test.

Variable	N	Mean	SD	DF	SE	T-cal	T-crit	P-value
ExptlGroup	40	45.85	3.01	78	0.84	2.72	1.99	0.01
Contl group	40	43.58	4.36		0.84			

From the table above, there were equal numbers of 40 pupils under both the experimental and control groups. Their mean score and standard deviation were 45.85, 43.58, 3.01 and 4.36 respectively. Also the T-calculated was 2.72 while the T-critical is 1.99 and the probability (p) value was p=0.01. However, from the on going analysis, the T-calculated was greater than the T-critical (T-cal > T-crit) while the probability value is less than the alpha value $\alpha = 0.05$ i.e. ($p = 0.01 < \alpha = 0.05$) adapted in this study.

Therefore, the results of the analysis suggested that the difference between the mean achievement of the experimental group and control groups was statistically significant. We then conclude that there was significant difference between the mean achievements of the experimental group and control group in addition and subtraction skills. Any differences observed are such that they could have arisen from sampling errors. The information relevant to the analysis is presented in table 4.09.

Research Question 4: Is there any significant difference between mean score of the male experimental and female experimental groups in addition and subtraction skills? In order to answer this question table 4.10 provided the data while table 4.11 gave a summary of the results.

Table 4.10 Scores for the experimental and control groups in level 2 Achievement test

Class- interval	MEGF	FEGF
37-39	0	3
40-42	1	6
43-45	3	4
46-48	12	5
49-51	4	2

Key:

MEGF: Male Experimental Group Frequency

FCGF: Female Experimental Group Frequency

Table 4.11: Means and Standard Deviations of the male experimental and female experimental groups in level 2 Achievement test

Variable	N	Mean	SD
MExptlgroup	20	46.75	2.31
FExplgroup	20	43.50	3.93

From table 4.11, the mean score of the male experimental group was 46.75 and a standard deviation of 2.31. While the mean score for the female experimental group was 43.50 and a standard deviation of 3.93. This proved that the experimental group had mean score more than the control group. This implied that the effects of the treatment have impact on the male experimental group. However, it is not enough to generalize the research intentions from the results of the research question. The significant test was carried out by means of the research hypothesis.

Null Hypothesis 4: There is no significant difference between mean score of the male experimental and female experimental groups in addition and subtraction skills. In order to analyze the hypothesis 4 above, table 4.12 below gave the summary of the analysis.

Table 4.12: Independent Sample Test of Difference between means of experimental group and control groups in level 2 Achievement test.

Variable	N	Mean	SD	DF	SE	T-cal	T-crit	P-value
MExptlGroup	20	46.75	2.31	18	1.02	3.19	2.02	0.01
FExptlgroup	20	43.50	3.93		1.02			

From the table above, there were equal numbers of 20 pupils under both the male experimental and female experimental groups. Their mean score and standard deviation were 46.75, 43.50, 2.31 and 3.93 respectively. Also the T-calculated was 3.19 while the T-critical is 2.02 and the probability (p) value was p=0.01. However, from the on going analysis, the T-calculated is greater than the T-critical (T-cal > T-crit) while the probability value is less than the alpha value α = 0.05 i.e. (p=0.01 < α =0.05) adapted in this study.

Therefore, the results of the analysis suggested that the difference between the mean achievement of the male experimental group and female experimental groups were statistically significant. We then conclude that there was significant difference between the mean achievements of the male experimental group and female experimental group in addition and subtraction skills. Any differences observed are such that they could have arisen from sampling errors. The g information relevant to the analysis is presented in table 4.12.

Research Question 5: Is there any significant difference between mean score of the experimental and control groups in commutative and associative additive skills? In order to answer this question table 4.13 provided the data while table 4.14 gave a summary of the results.

Table 4.13 Scores for the experimental and control groups in level 2 Achievement test

Class- interval	EGF	CGF
37-39	0	3
40-42	10	13
43-45	6	9
46-48	18	9
49-51	6	6

Key:

EGF: Experimental Group Frequency

CGF: Control Group Frequency

Table 4.14: Means and Standard Deviations of the experimental and control groups in level 2 Achievement test

Variable	N	Mean	SD
Exptlgroup	40	45.23	3.20
Contlgroup	40	43.98	3.59

From table 4.14, the mean score of the experimental group was 45.23 and a standard deviation of 3.20. While the mean score for the control group was 43.98 and a standard deviation of 3.59. This proved that the experimental group had mean score more than the control group. This implied that the effects of the treatment have impact on the experimental group. However, it is not enough to generalize the research intentions from the results of the research question. The significant test was carried out by means of the research hypothesis.

Null Hypothesis 5: There is no significant difference between mean score of the experimental and control groups in commutative and associative additive skills. In order to analyze the hypothesis 5 above, table 4.15 below gave the summary of the analysis.

Table 4.15: Independent Sample Test of Difference between means of experimental group and control groups in level 2 Achievement test

Variable	N	Mean	SD	DF	SE	T-cal	T-crit	P-value
ExptlGroup	40	45.28	3.20	78	0.76	1.71	1.99	0.09
Contl group	40	43.98	3.59		0.76			

From the table above, there were equal numbers of 40 pupils under both the experimental and control groups. Their mean score and standard deviation were 45.28, 43.98, 3.20 and 3.59 respectively. Also the T-calculated was 1.71 while the T-critical is 1.99 and the probability (p) value was p=0.09. However, from the on going analysis, the T-calculated was less than the T-critical (T-cal < T-crit) while the probability value is greater than the alpha value $\alpha = 0.05$ i.e. ($p = 0.09 > \alpha = 0.05$) adapted in this study.

Therefore, the results of the analysis suggested that the difference between the mean achievement of the experimental group and control groups was not statistically significant. We then conclude that there was no significant difference between the mean achievements of the experimental and control groups in commutative and associative additive skills. Any differences observed are such that they could have arisen from sampling errors. The information relevant to the analysis is presented in table 4.15.

4.4 Summary of the Findings

From the Independent Sample Test, it has been confirmed that null hypotheses 1, 2, 3 and 4 were rejected while null hypothesis 5 was upheld. It was statistically shown that there were significant differences in the mean scores between the experimental and the control groups in addition skills, subtraction skills and in the combination of addition and subtraction skills.

It has also revealed that there was significant difference in the mean score between the male and female experimental groups. While there was no significant difference in the mean scores between the experimental and control groups in commutative and associative additive skills.

4.5 Discussion of Results

This unit presented explanation of results obtained fro the hypotheses tested and acknowledged the published works of other authors in the study.

Research Question 1: Is there any significant difference between mean score of experimental and control groups in addition skills?

Null Hypothesis 1: There is no significant difference between mean score of experimental and control groups in addition skills. Table 4.03 proved that there was high significant difference between mean score of the experimental and control groups in addition skills. This suggested that the Tri-constructs teaching strategy has favoured the experimental groups.

This confirmed the findings of Hmelo- Silver, Duncan & Chinn (2007) “Student using the GenScope Software showed significant gains over the control groups with largest gains shown in students from basic courses”.

Research Question 2**:** Is there any significant difference between mean score of the experimental and control groups in subtraction skills?

Null Hypothesis 2: There is no significant difference between mean score of the experimental and control groups in subtraction skills. Table 4.06 confirmed that there was significant difference in the mean score of the experimental and control groups in subtraction skills. This confirmed the study of Dogru and Kalender (2007) which found no significant differences between traditional and constructivist methods. However, in the follow-up assessment 15days later, students who learned through constructivist methods showed better retention of knowledge than those who learned through the traditional methods".

Research Question 3: Is there any significant difference between mean score of the experimental and the control groups in addition and subtraction skills?

Null Hypothesis 3: There is no significant difference between mean score of the experimental and control groups in addition and subtraction skills.

It was established in Table 4.09 that there was a significant difference between mean score of the experimental and control groups in addition and subtraction skills. This confirmed that the Tri-constructs teaching strategy gained upper hand than the traditional method. This confirmed the study of Guthrie et al (2004) "The constructivist approach called CORI (Concept –

Oriented Reading Instruction) resulted in better student reading comprehension, cognitive strategies and motivation between the traditional approach and the strategies instruction approach".

Research Question 4: Is there any significant difference between mean score of the male experimental and female experimental groups in addition and subtraction skills?

Null Hypothesis 4: There is no significant difference between mean score of the male experimental and female experimental groups in addition and subtraction skills. Table 4.12 vindicated that there was high significant difference between mean score of the male experimental and the female experimental groups. It further proved that the Tri-constructs teaching strategy favoured the male experimental group. This confirmed the study of Hmelo-Silver et al. (2007) "That the Inquiry - Base teaching methods greatly reduced the performance or achievement gap for African – American students".

Research Question 5: Is there any significant difference between mean score of the experimental and control groups in commutative and associative additive skills (Discovery method)?

Null Hypothesis 5: There is no significant difference between mean score of experimental and control groups in commutative and associative additive skills (Discovery method). Finally, Table 4.15 reported that there was no significant difference between mean score of the experimental and control groups in commutative and associative additive skills (Discovery method). This proved that the Tri- constructs teaching strategy did not favour the experimental group.

However, the discussion can be concluded that the purposes and objectives of the study have been achieved. This confirmed the study of Piaget and other constructivist scholars. Therefore, Tri-constructs should be seen as a strategy that enhanced the teaching and learning or the achievements of pupils in addition and subtraction skills at primary school level.

4.6 Summary of the chapter

The study was conducted on primary three pupils of Model primary school in kaduna state with sample size of 80 pupils. Five research questions and hypotheses were tested and the results of each were shown. From the results obtained it has been statistically proved that null hypotheses 1, 2, 3, and 4 were rejected while null hypothesis 5 was upheld. Also from the discussion of the results it has been shown that Tri-constructs teaching strategy favoured the experimental group. It further shown that Tri-constructs teaching strategy has made more impact on teaching addition and subtraction skills than the traditional method.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter was discussed under the following headings, summary, conclusion and recommendation.

5.1 Summary

From the results of the analyses discussed in 4.3, the Tri-constructs teaching strategy favoured the experimental group in addition skills. This provided a positive response to the question; is there any significant difference between mean score of the experimental and control groups in addition skills. The study shows that, there is significant difference between the achievement of pupils taught by the Tri-constructs teaching strategy and those taught by traditional method. The study further confirmed that Tri-constructs teaching strategy is a good tool in teaching addition skills at primary school level.

Tri-constructs teaching strategy favoured the experimental group in subtraction skills. This provided a positive response to the question; is there any significant difference between mean score of the experimental and control groups in subtraction skills. The study shows that, there is significant difference between the achievement of pupils taught by the Tri-constructs teaching strategy and those taught by traditional method. The study further confirmed that Tri-constructs teaching strategy is a good tool in teaching subtraction skills at primary school level.

Tri-constructs teaching strategy favoured the experimental group in addition and subtraction skills. This provided a positive response to the question; is there any significant difference between mean score of the experimental and control groups in addition subtraction skills. The study shows that, there is significant difference between the achievement of pupils taught by the Tri-constructs teaching strategy and those taught by traditional method. The study further confirmed that Tri-constructs teaching strategy is a good tool in teaching addition and subtraction skills at primary school level.

Tri-constructs teaching strategy favoured the male experimental group in addition and subtraction skills. This provided a positive response to the question; is there any significant difference between mean score of the male experimental and female experimental groups in addition and subtraction skills. The study shows that, there is significant difference between the achievement of male pupils taught by the Tri-constructs teaching strategy and those taught by traditional method. The study further confirmed that Tri-constructs teaching strategy is a good tool in teaching addition and subtraction skills at primary school level.

Tri-constructs teaching strategy did not favoured the experimental group in commutative and associative additive skills. This provided a negative response to the question; is there any significant difference between mean score of the experimental and control groups in commutative and associative additive skills. The study shows that, there is no significant difference between the achievement of pupils taught by the Tri-constructs teaching strategy and those taught by traditional method. The study further confirmed that Tri-constructs teaching strategy has made no any impact on teaching commutative and associative additive skills at primary schools.

This might be due to the following reasons; 1. Time; the tri-constructs teaching strategy was observed for a period of 8 weeks as done by some researchers, possibly this period might be small to a newly teaching strategy that was observed to children. 2. The atmospheric condition; the condition of the school where the treatment took place might not be conducive for teaching and learning. 3. Samples; the larger the number of pupils sampled for the research the better. This study used only 80 pupils as sample out of 7669. Therefore, more samples might have been used. 4. Lack of writing materials and practicing the given homework in the school and at home might caused the failure of Tri-constructs teaching strategy to made any impact on commutative and associative additive skills. However, these reasons and many more could be advanced for the inability of the tri-constructs teaching strategy to make any impact on the experimental group.

However, this is a challenge that should be investigated by next researchers.

5.2 Conclusion

This unit gave inferences drawn from the findings. Thus:

Generally, it was confirmed that there was high significant difference between the mean achievements of the experimental and control groups in addition skills, subtraction skills and in the combination of addition and subtraction skills. And there was high significant difference between the mean achievements of the male experimental and female experimental groups in addition and subtraction skills. This further confirmed that the Tri-constructs teaching strategy has gained more than the Traditional method of teaching.

However, it was statistically shown that Tri-constructs teaching strategy did not favoured experimental group in commutative and associative additive skills. This might be that the time taken for the treatment was not enough. Since it was a new strategy more time might be required to teach the pupils. The sample used might be small because the larger the sample the better. Lack of good condition and writing materials by the pupils might be another factor for the failure of Tri-constructs teaching strategy to made any impact on commutative and associative additive skills etc. These are challenges to the researcher and the next researchers to come.

Tri-constructs teaching strategy favoured the experimental groups was due to the fact that the pre-requisite steps of activities in teaching of addition and subtraction skills were followed .This has stimulated pupils’ attention and interest, which led to good performance and achievement in addition and subtraction skills. The pupils were taught with the strategy of expanded notation without concrete materials and the conventional notation by the used of pocket charts to enhance their understanding on addition and subtraction with or without renaming. The pupils became more active and creative in using the discovery method of teaching commutative and associative additive skills. A lot of exercises were given to the pupils to stimulate their interest and creativeness. Other methods like Gestalt, Group, Individual methods etc were also used to enhance the teaching strategy.

Based on the empirical evidences presented Tri-constructs teaching strategy has gained more than the traditional method and enhanced the performance and achievement in addition and subtraction skills of pupils at primary level. It became obvious to recommend that the strategy be used as teaching instruction in addition and subtraction skills at primary school level in Nigeria. Our prospective researchers will be left with the fundamental question; what is the effect of the Tri-constructs teaching strategy on addition and subtraction skills in secondary schools?

5.3 Recommendation

This unit listed possible ways of solving the problems identified by the study and areas for further researches. The following recommendations on measures to be considered to enhance pupils' skills in addition and subtraction at primary school level by the 21^{st} century and beyond are discussed under the following major paragraphs:

In the course of the study a number of problems were identified such as lack of interest/attention and poor attitude by the pupils. Lack of teaching materials in the schools taught was frequent. Lacks of good atmospheric condition for learning because some buildings were not good, pupils were exposed to cold. Some teachers did not have the knowledge of the current trends in mathematics education as such the use of current researches in mathematics is not realistic. Parents do not help their children at homes when they are given homework this could be due to the fact that they have poor attitude to ward the subject. Some administrators do not provided the needed infrastructure and fund that support meaningful teaching and learning to take place in the model primary schools in the state. It was observed that Tri-constructs teaching strategy failed to make any impact on the experimental group in commutative and associative additive skills. Some measures were suggested by the researcher below;

All goals point to one primary goal: all pupils will gain “mathematical power”. The NCTM (1989) defines mathematical power as “an individual’s abilities to explore, conjecture, and reason logically, as well as the ability to use a variety of mathematical methods to solve no routine problems”. This goal challenges pupils, teachers, and administrators, parent’s community members to create and implement a comprehensive plan for the improvement of mathematics education.

The pupils should take advantage of opportunities to engage actively in learning addition and subtraction skills. Develop skills and processes for manipulative, reasoning, communicating, and connecting concepts within and outside addition and subtraction skills. Respond to question asked and be ready to learn at all situations. Learn to be loyal, dedicated to work and cooperate with their teachers. Engage in individual or group work as the case may be and pay attention to what the teacher is teaching. This will create the much needed attention and interest in teaching addition and subtraction skills as advocated by Piaget.

To implement reforms that engage all pupils in meaningful mathematics learning, teachers will need to learn a new role as a facilitator and coach in the classroom expand their knowledge base in addition and subtraction skills, develop new curricular and instructional strategies. Teachers should need to develop positive attitudes toward and genuine interest in mathematics and examine, continue to learn about how children learn addition and subtraction skills. Offer activities that encompass various learning styles and instructional formats to stimulate learning for all pupils. Engage pupils in an active process of learning addition and subtraction skills in which they create and discover mathematical concepts. Use a variety of assessment alternatives to gain information about what pupils understand how they feel about addition and subtraction skills in order to help them learn. Facilitate learning by posing open-ended questions, asking pupils to clarify and justify their ideas, and encouraging them to seek assistance from one another. Engage pupils in the use of manipulative materials and active mental involvement to support their learning of addition and subtraction skills. Teach children specific addition and subtraction skills and how to apply such skills in the context of problem-solving situations. This will enhance the teaching of addition and subtraction skills in pupils at primary level. It will also create interest and attention to the lesson as advocated by many constructivist scholars.

All administrators should exercise instructional leadership in articulating a unifying vision of mathematics teaching and learning. They also support and encourage mathematics teachers who are working together and with other teachers and community members to help provide mathematically significant learning experiences for all pupils. All parents and community should meaningfully engaged in helping the school community approach and program; providing resources for supporting this new Tri-Constructs teaching strategy and modeling this new vision in their direct interactions with pupils. Provide learning opportunities in the home, allowing pupils to participate in activities that stimulate reasoning and learning in addition and subtraction skills.

5.4 Limitations

Mathematics education is faced with numerous problems be it; poor attitude, interest, teacher, content, performance, achievements, instructional strategies, etc. The area of this study was model primary schools in Kaduna state hence the findings may not necessarily binding on other public or schools in the state.

A sample of 80 pupils was used and the findings were generalized on the entire population of 7669 pupils. Had it been that the sample size was larger the findings would have been better for generalization. The mean, standard deviations and errors of the scores were computed and presented in chapter four and any error may be due to humanity. This study focused attention on effect of constructivist teaching strategy on addition and subtraction skills while other aspects like poor; attitude, interest, content teacher factor, etc may be investigated by further researchers.

5.5 Suggestions for further Studies

This research intended to promote and encourage further findings in the related studies; hence the following research areas were suggested.

1. Effect of attitude and interest on constructivist teaching strategy in addition and subtraction skills in primary schools of Kaduna state.
2. Effect of teacher factor on the constructivist teaching strategy in addition and subtraction skills in Kaduna state.
3. Effect of constructivist teaching strategy on commutative and associative additive skills in primary schools of Kaduna state or Nigeria.
4. Effect of constructivist teaching strategy on addition and subtraction skills in junior secondary schools of Kaduna state or Nigeria at large.
5. Effect of constructivist teaching strategy on multiplication and division skills primary schools of Kaduna state or Nigeria.
6. Effect of constructivist teaching strategy on directed numbers and number operations in junior secondary schools of Kaduna state or Nigeria at large.

7. Effect of gender in constructivist teaching strategy on addition and subtraction skills in junior secondary schools of Kaduna state or Nigeria at large.

8. Effect of gender in constructivist teaching strategy on multiplication and division skills in junior secondary schools of Kaduna state or Nigeria at large.

9. The relationship between constructivist approaches to mathematics teaching and social-cultural norms in mathematics classroom for Nigerian public primary and secondary schools.

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LEVEL 1 ACHIEVEMENT TEST APPENDIX B

ANSWER ALL QUESTIONS

TIME ALLOWED 1hr.

1. (a) $\begin{array}{r} 12 \\ +\ 57 \\ \hline \end{array}$ (b) $\begin{array}{r} 111 \\ +\ 33 \\ \hline \end{array}$ (c) $\begin{array}{r} 435 \\ +\ 413 \\ \hline \end{array}$

2. (a) $\begin{array}{r} 64 \\ +\ 76 \\ \hline \end{array}$ (b) $\begin{array}{r} 374 \\ +\ 57 \\ \hline \end{array}$ (c) $\begin{array}{r} 886 \\ +\ 338 \\ \hline \end{array}$

3. (a) $\begin{array}{r} -\ 33 \\ -\ 22 \\ \hline \end{array}$ (b) $\begin{array}{r} -\ 336 \\ 13 \\ \hline \end{array}$ (c) $\begin{array}{r} -\ 456 \\ 241 \\ \hline \end{array}$

4. (a) $\begin{array}{r} -\ 47 \\ 19 \\ \hline \end{array}$ (b) $\begin{array}{r} -\ 337 \\ 29 \\ \hline \end{array}$ (c) $\begin{array}{r} -\ 477 \\ 288 \\ \hline \end{array}$

5. (a). There are 138 boys in one-class and35 boys in another.

How many boys are there altogether?

(b). There are 50 eggs in one basket and 65 in another. How man

Many eggs are there in both the basket?

(C). There are 159 girls in one row in the class and 174 in another

How many girls are there in both the rows?

(a). There are 65 boys in one-class.22 boys taken away. How ma

Many boys are left in the class?

(b). A girl has 55k. She gives her sister 28k. How many kobo

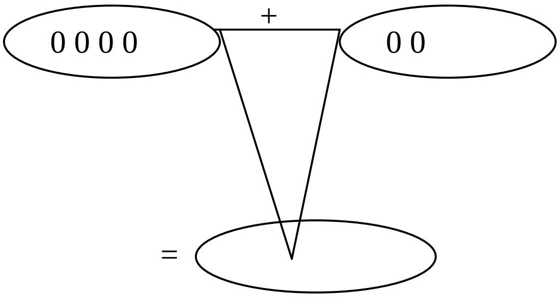
does she have now?

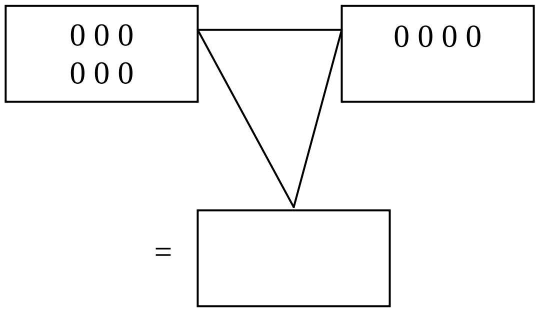
(c). I have 433k. I spend 148k. How many kobo do I have now?

LVEL 2 ACHIEVEMENT TEST **APPENDIX C**

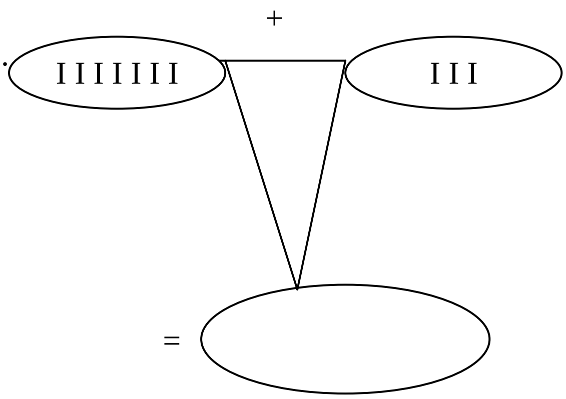
INSTRUCTION: Answer all questions
TIME ALLOWED: One Hour (1 hr).

1.

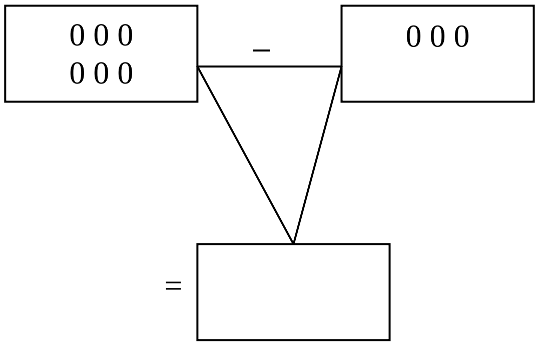




3.



4.



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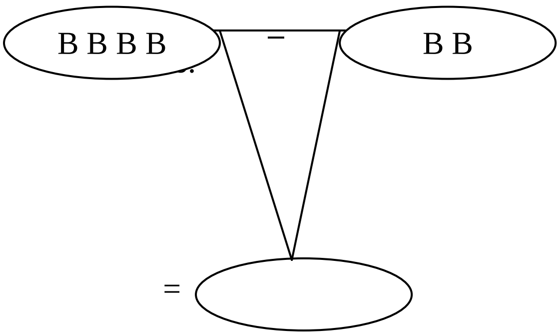
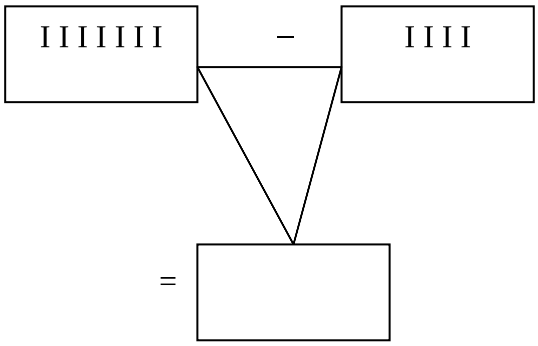


6.



7. 2 tens + 3 ones
+ 3 tens + 2 ones
____

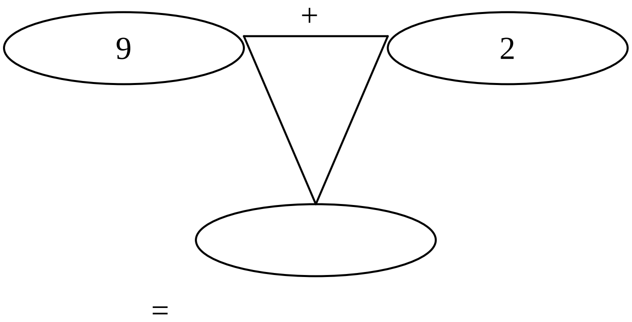
8. 6 tens + 3 ones
+ 7 tens + 2 ones
____

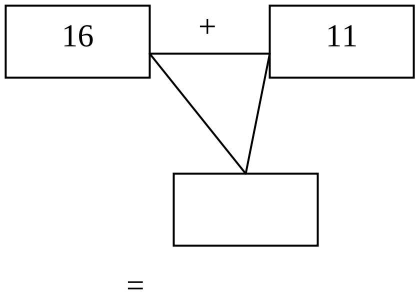
9. 3 tens + 13 ones = 3 tens + (1 ten + 3 ones)
= (3 tens + 1 ten) + 3 ones
= ______________
____

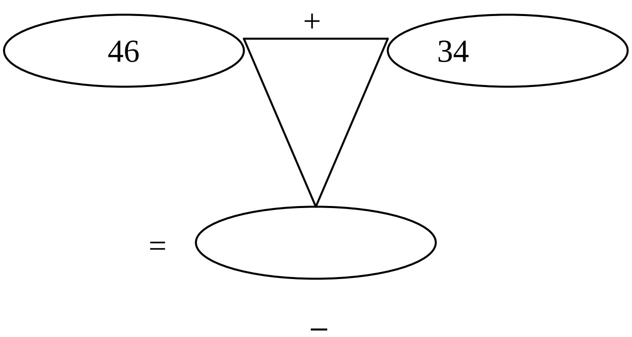
10. 3 tens – 7 ones = (2 tens + 10 ones) – 7 ones
= 2 tens + (10 ones – 7 ones)
= ______________

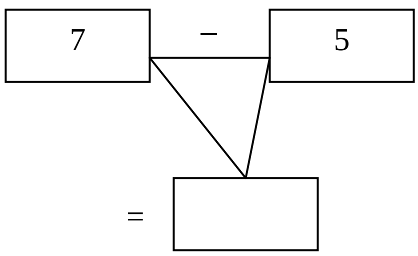
11. 4 tens + 9 ones
_ 2 tens + 7 ones
____

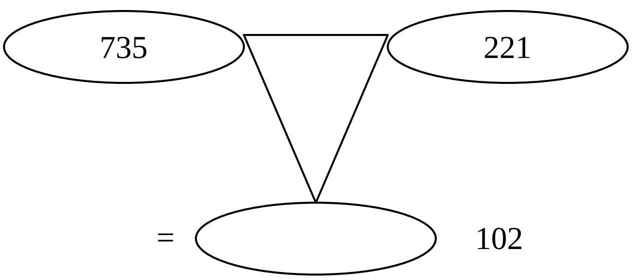
12. _ 5 tens + 2 ones = (4 tens + 10 ones)+2ones
3 tens + 8 ones 4 tens + (10 ones+2ones)
_4 tens + 12 ones
3 tens + 8 ones
____

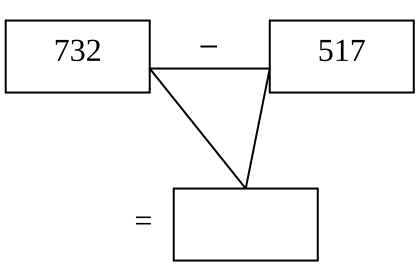
13.


14.


15.


16.


17.


18.


19.

	T	U
	4	6
+	2	2

OR

	T	U
	I I I I	I I I I I I
+	I I	I I
	I I I I I I	**I I I I I I I I**

20.

	H	T	U
	2	3	4
+	1	2	3

OR

	H	T	U
	I I	I I I	I I I I
+	I	I I	I I I
	I I I	**I I I I I**	**I I I I I I I**

21.

	H	T	U
	2	1	9
+	3	0	3

OR

	H	T	U
	I I	I	I I I I I I I I I
+	I	0	I I I
	I I I I I	**I I**	**I I**

22.

	T	U
	4	6
-	2	1

OR

	T	U
	I I I I	I I I I I I
-	I I	I
	I I	**I I I I I**

23.

	H	T	U
	7	3	2
-	5	1	1

OR

	H	T	U
	I I I I I I I	I I I	I I
-	I I I I I	I	I
	I I	**I I**	**I**

24.

	H	T	U
	7	3	2
-	5	1	7
	2	1	5

OR

	H	T	U
	I I I I I I I	I I I	I I
-	I I I I I	I	I I I I I I I
	I I	**I**	**I I I I I**

25.

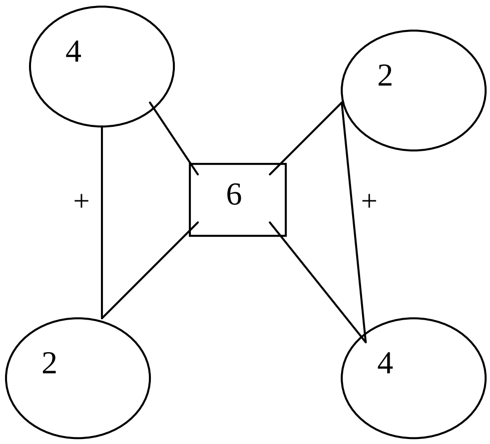
3 + 2 = 2 + 3

5 =

3 + 2 = 2 + 3

5 =

26



4 + 2 = 2 + 4

6 =

27.

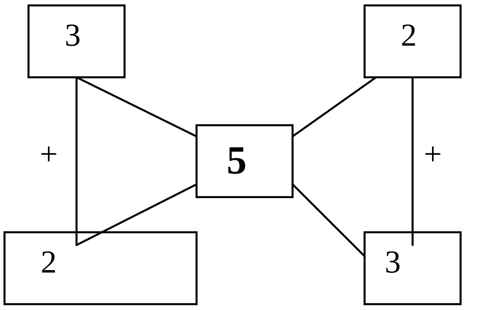
3 + 2 + 4 = 4 + 2 + 3

3 + 2 + 4 = 4 + 2 + 3

5 + 4 = 4 + 5

=

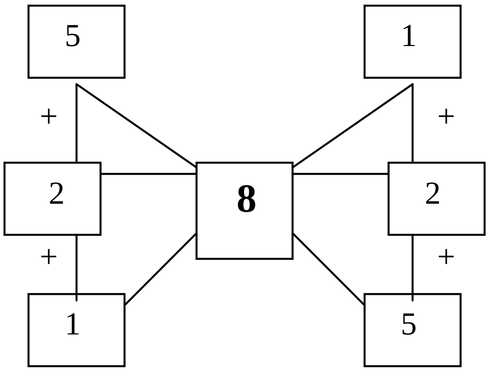
28 COMMUTATIVE PROPERTY OF ADDITION



3 + 2 = 2 + 3

5 = ☐

29. ASSOCIATIVE PROPERTY OF ADDITION



5 + 2 + 1 = 5 + 2 + 1

(5 + 2) + 1 = 5 + (2 + 1)

7 + 1 = 5 + 3

8 = ☐

TRADITIONAL METHOD OF TEACHING **APPENDIX D**

ADDTION OF NUMBERS HUNDREDS, TENS UNITS (3-DIGIT NUMBERS)

ADDITON WITHOUT RENAMING

Example: Add 213 and 224 **LESSON 1.**

			H	T	U
200 + 10 +3			2	1	3
200 + 20 + 4		+	2	2	4
400 + 30 + 7	=		4	3	7

Exercise 1

1)	224 + 35 259	263 + 26 289	52 + 236 288	73 + 314 387	213 + 56 269
2)	362 +110 472	510 + 262 772	604 + 330 934	403 + 504 907	435 +413 848
3)	330 +211 541	462 + 306 768	850 +120 970	260 + 120 380	815 + 341 1156
4)	252 + 323 575	403 + 302 705	848 + 331 1179	413 + 342 755	288 + 511 799

ADDITION WITH RENAMING

Example 1: Add 35 and 36

35	→ 30 + 5		35
+ 86	80 + 6		+ 86
		= 100 + 10 + 10 + 1 = 100 +20 + 1 =	121

EXERCISE.

	a.	b.	c.	d.	e.
1.	65	37	28	73	24
	+54	+ 65	+ 43	+ 32	+ 77
	119	102	71	105	101
2.	24	38	47	53	65
	+76	+95	+64	+ 29	+19
	100	133	111	82	84
3.	57	23	64	75	84
	+ 68	+59	+ 76	+25	+ 57
	125	82	140	100	141
4.	36	35	47	17	22
	+59	+ 28	+ 23	+ 53	+ 43
	95	63	70	70	65
5.	57	56	23	53	71
	+ 16	+ 48	+28	+ 59	+53
	73	104	51	112	124

EXAMPLE: Add 136 and 84. **LESSON 3**

H	T	U
1	3	6
+	8	4
2	**2**	**0**

Add.

1. a.	b.	c.	d.	e.
142	254	364	185	365
+ 83	+ 70	+ 87	+ 37	+ 80
225	324	451	222	445

2. 431	550	375	797	450
+ 92	+ 85	+56	+47	+83
523	635	431	844	533
3. 844	863	783	696	576
+71	+56	+48	+88	+85
915	919	831	784	661
4. 553	464	394	398	686
+63	+75	+69	+58	+86
616	539	463	456	772
5.265	150	276	886	450
+80	+83	+85	+86	+499
345	233	351	972	949

Example: Add224and 279.

	H	T	U
+	2	2	4
	2	7	9
	5	0	3

Add

	b.	c.	d.	e.
1.a. 114	432	335	162	365
+493	+372	+ 582	+ 686	+ 154
607	804	917	848	519

2.322	251	254	373	437
+295	+487	+694	+561	+265
617	738	948	934	702

3.241	343	363	184	543
+586	+595	+563	+753	+384
827	938	926	937	927

4.153	454	153	142	805
+653	+272	+766	+872	+185
806	726	919	1014	990

5. 289	315	435	314	719
+318	+599	+488	+387	+225
607	914	923	701	944

WORD PROBLEMS ON ADDITION LESSON 5

Example 1: there are 12 goats and 15 goats T
U
How many goats are there altogether? 1
2
There are 12 goats + 1
5
and 15 goats. 2
7
Altogether there are 27 goats.

EXERCISE.

1. How many are there altogether? (a) 8 goats (b) 9 goats (c) 27 goats (d.) 81 goats.
2. There are 27 trees in one garden and 38 trees in another. How many trees are there in both the gardens? In one garden there are 27 trees. In another there are 38 trees. There are 65 trees in both the gardens.
3. There are 46 eggs in one basket and 65 eggs in another. How many eggs are there in both the basket and 65 eggs in another basket? There are 111 eggs in both the baskets.
4. There are 38 boys in one bus and 35 girls in another. How many children are there in both the buses? There are 38 boys in one bus and 35 girls in another. There are 73 children in both the buses.
5. There are 39 chairs in one class and 38 chairs in another. How many chairs are there altogethers in the two classes? In one class there are 39 chairs. Altogether there are 77 chairs in the two classes.
6. There are 150 stalls in one row in the market and 174 in another row. How many stalls are there in both rows? There are 324

8. Obunna's mother bought him 48 oranges and later his father bought him 105 oranges. How many oranges were bought altogether for him 153

9.The headmaster admitted 347 pupils into the school in 1996 and 209 in 1997. How many did he admit into the school in both years? 556

10. In one town there are 131 houses and in another there are 89. How many houses are in the two towns? 220

11.Two families have 287 goats each. How many goats have the two families? 574.

SUBTRACTION OF NUMBERS (3. DIGIT NUMBERS)

HUNDRES, TENS AND UNITS **LESSON I**

SUBTRACTION WITHOUT RENAMING

EXAMPLE: Subtract 121 from 352.

300 + 50 + 2		**H T U**
- 100 + 20 + 1		**3 5 2**
200 + 30 + 1	**=**	**1 2 1**
		2 3 1

EXERCISE 1

1. a.	b.	c.	d.	e.
142	427	336	267	258
-30	-13	-120	- 43	-37
112	414	216	224	221

2.163	536	455	378	549
-40	- 115	- 230	- 55	- 238
123	421	225	323	311

3	274	648	679	483	695
	-50	-33	-360	-63	-381
	224	615	319	420	314

4.	381	759	548	595	769
	-70	-248	- 420	-84	-247
	311	511	128	511	522

5.	473	843	515	455	854
	-122	- 731	-300	- 32	- 323
	351	112	215	423	531

EXAMPLE 1: RENAME 708.

708	=	7 hundreds + 0 tens + 8 units	= 700 + 0 + 8
	=	6 hundreds + 10 tens + 8 units	= 600 + 100 + 8
	=	6 hundreds + 9 tens + 18 units	= 600 + 90 +18

EXAMPLE 2 RENAME 400

400	=	4 hundreds + 0 tens + 0 units	= 400 + 0 +0
		3 hundreds + 10 tens + 0 units	= 300 + 100 +0
		3 hundreds + 9 tens + 10 units	= 300 + 90 +10

EXERCISE 2

COMPLETE THE FOLLOWING.

1.473	=	4 hundreds + 7 tens + 3 units	= 400 + 70 + 3
	=	4 hundreds + 6 tens + 13 units	= 400 + 60 + 13
	=	3 hundreds + 16 tens + 13 units	= 300 + 160 + 13
2. 811	=	8 hundreds + 1 tens + 1 unit	= 800 + 10 + 1
	=	8 hundreds + 7 tens + 11 units	= 800 + 70 + 11
	=	7 hundreds + 10 tens + 11 units	= 700 + 100 + 11
3. 602	=	6 hundreds + 0 tens + 2 units	= 600 + 0 + 2
	=	5 hundreds + 10 tens + 2 units	= 500 + 100 + 2
	=	5 hundreds + 9 tens + 12 units	= 500 + 900 + 12
4. 800	=	8 hundreds + 0 tens + units	= 800 + 0 + 0
	=	7 hundreds + 10 tens + 0 units	= 700 + 10 + 0
	=	7 hundreds + 9 tens +10 units	= 700 + 90 +10

5. 550 = 5 hundreds + 5 tens + 0 units = 500 + 50 + 0

= 5 hundreds + 4 tens + 10 units = 500 + 40 +10

= 4 hundreds + 14 tens + 10 units = 400 + 140 + 10

6. 237 = 2 hundreds + 3 tens + 7 units = 200 + 30 + 7

= 2 hundreds + 2 tens + 17 units = 200 + 20 + 17

= 1 hundred + 12 tens + 17 units = 100 + 120 + 17

SUBTRACTING NUMBERS. **LESSON 3.**

SUBTRACTION WITH RENAMING

EXAMPLE: Subtract 324 from 432.

4 3 2	400 + 30 + 2	**Rename**	400 + 20 + 12	4 3 2
- 3 2 4	- 300 + 20 + 4		- 300 + 20 + 4	- 3 2 4
______	______		100 + 0+ 8	= 1 0 8

1.

	a.	b.	c.	d.	e.
	268	359	488	368	626
	-173	-284	-192	-175	-268
	95	75	296	193	358

2.	420	475	530	645	715
	-230	-290	-340	-470	- 458
	190	185	190	175	257
3.	642	731	636	738	943
	- 357	-563	-263	-349	-576
	185	168	373	389	367
4.	825	934	856	942	835
	-352	-843	-765	-824	-489
	473	91	91	118	346

SUBTRACTION WITH CARRYING **LESSON 4.**

EXAMPLE: Subtract 185 from 291

	H	T	U
	2	**9**	**11**
–	**1**	**8**	**5**
	1	**0**	**6**

EXERCICE,

	a.	b.	c.	d.	e.
1.	145	192	337	263	588
	-28	-76	-29	-35	-79
	117	116	308	228	509
2.	229	255	137	182	248
	-63	-80	-55	-91	-58
	166	175	82	91	190
3.	348	282	611	477	172
	- 159	-184	-446	- 219	- 154
	189	98	165	258	18
4.	452	675	784	575	356
	- 279	-419	-186	-296	- 277
		173	256	598	279
	79				

EXERCISE.

	a.	b.	c.	d.	e.
1.	**468**	347	824	543	873
	- 275	- 163	- 545	- 365	- 688
	193	184	279	178	185
2.	913	822	906	724	743
	- 567	- 544	- 637	- 546	-556
	346	278	269	178	187
3.	404	759	821	911	849
	- 212	- 494	-323	- 632	-685
	1 9 2	265	498	279	285
4.	546	878	836	859	873
	- 358	-568	- 459	-655	- 685
	188	310	377	204	188

WORD PROBLEMS ON SUBTRACTION LESSON 5

Eaxample: Aboy has 24k. He spends 16k. How many kobo does he have?

	T	U
A boy has 24k	2	4
He spends 16k	- 1	6
He has 8k		8

EXERCICE:

1. a. 6 tens from 10 tens = 4 tens b. 8 tens from 11 tens = 3 tens
   c. 7 tens from 16 tens = 9 tens d. 9 tens from 17 tens = 8 tens

2. There are 65 fishes in a basket. 28 fishes are sold. Hoe many are left in the basket?
   There are 65 fishes in a basket.
   28 fishes are sold.
   There are 37 fishes left

3. I have 41k. 1 spends 19k. How many kobo do I have now?
   I have 41k.
   I spend 19k.
   I have 22 k left.

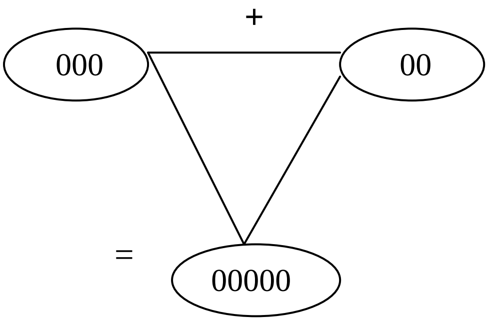
4. There are 65 sacks in a lorry. 48 sacks are taken away. How many sacks are left in the lorry?
   There are 65 sacks in a lorry.
   48 sacks are taken away.
   There are 17 sacks left in the lorry.

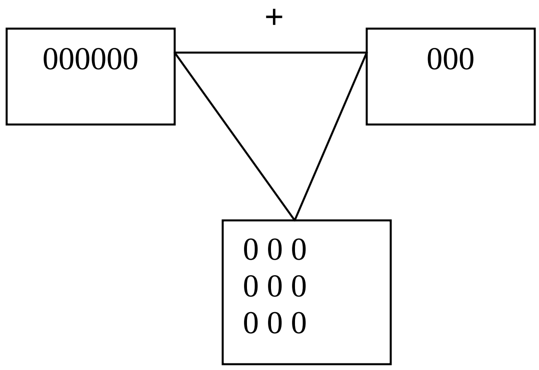
5. A girl has 55k. She gives her sister 28k. How many kobo does she have now?
   A girl has 55k.
   She gives 28k to her sister.
   Now she has 27k left.

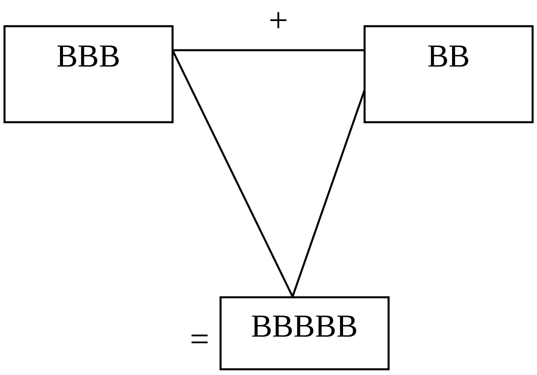
TRI-CONSTRUCTS TEACHING STRATEGY APPENDIX E

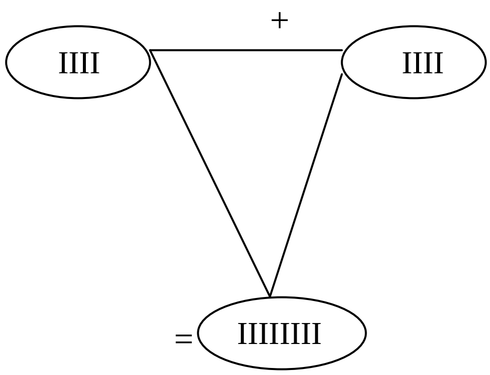
TRI-CONSTUCTS ADDITION. LESSON1.

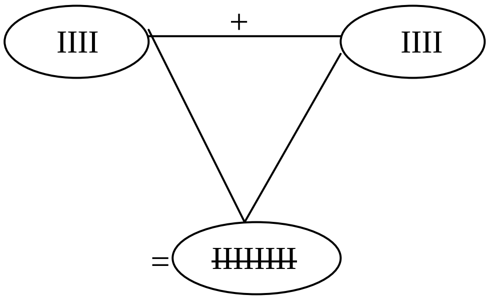
1. CONCRETE METERIALS











EXPANDED NOTATION WITHOUT CONCRETE MATERIALS

LESSON 2.

2. **a.** 3 tens +2 ones
+3 tens +6 ones
7 tens + 8 ones

b. 5 tens + 3 ones
+6 tens + 5 ones
11 tens + 8 ones

c. 2 tens + 12 ones
= 2 tens + (1 tens +2 ones)
(2 tens + 1 ten) + 2 ones
3 tens +2 ones

d. 3 tens + 6 ones
+ 2 tens + 7 ones
5 tens + 13 ones
5 tens + (1 tens + 3 ones)
(5tens + 1 ten) + 3 ones
6 tens + 3 ones

LESSON 3.

a.

	T	U
	3	2
+	4	6
	7	8

OR

	T	U
	TENS	**ONES**
+	111	11
	1111	111111
	1111111	**11111111**
	7	**8**

b.

	H	T	U
	2	3	4
+	1	2	4
	3	5	8

OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
+	11	111	1111
	1	11	1111
	111	**11111**	**11111111**
	3	**5**	**8**

c.

	H	T	U
+	2	1	9
	3	0	3
	5	2	2

OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
+	11	1**1** ←	111111111
	111	0	**1**11
	11111	**11**	**11**
	5	**2**	**2**

d.

	H	T	U
	1	9	3
+	1	2	8
	3	2	1

OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
+	1**1** ←	111111111**1** ←	111
	1	**1**1	**1**1111111
	111	**11**	**1**
	3	**2**	**1**

e.

	H	T	U
	2	9	4
+	1	2	8
	4	2	2

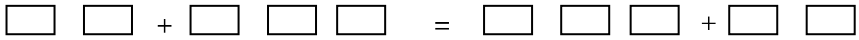
OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
+	11**1** ←	111111111**1** ←	1111
	1	**1**1	**1**1111111
	1111	**11**	**11**
	4	**2**	**2**

LESSON 4.

4 ADDITIVE COMMUTATIVE PROPERTY

a.



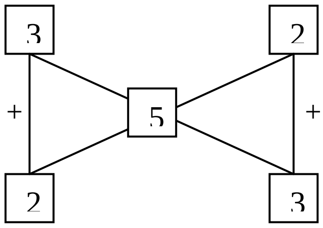
2 + 3 = 3 + 2

5 = **5**

2 + 3 = 3 + 2

5 = 5

b.

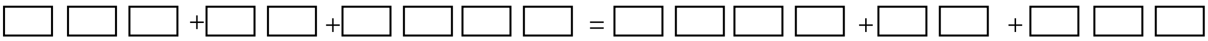


3 + 2 = 2 + 3

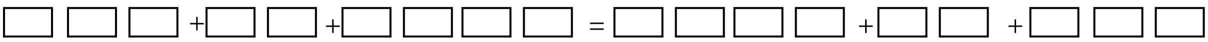
5 = 5

ADDITIVE ASSOCIATIVE PROPERTY

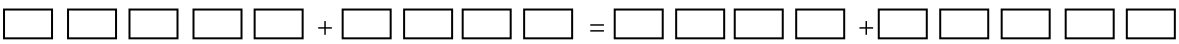
a



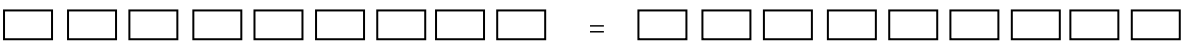
3 + 2 + 4 = 4 + 2 +
3



(3 + 2) + 4 = 4 + (2 + 3)



5 + 4 = 4 + 5



9 = **9**

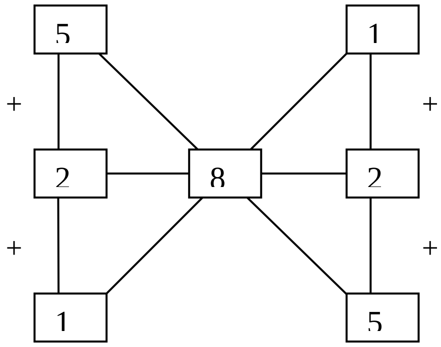
3 + 2 + 4 = 4 + 2 + 3

(3 + 2) + 4 = 4 + (2 + 3)

5 + 4 = 4 + 5

9 = **9**

b



$$5 + 2 + 1 = 5 + 2 + 1$$

$$(5 + 2) + 1 = 5 + (2 + 1)$$

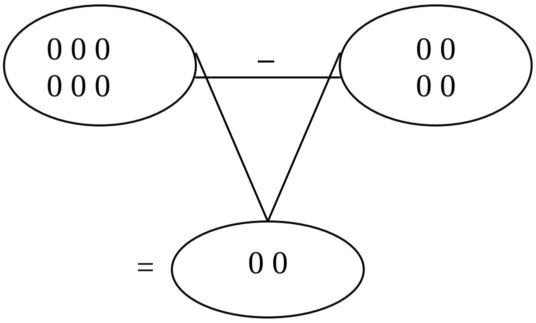
$$7 + 1 = 5 + 3$$

$$\mathbf{8} = \mathbf{8}$$

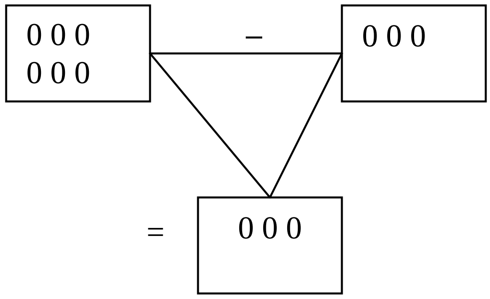
TRI – CONSTRUCTS SUBTRACTION **LESSON I.**

1. CONCRETE MATERIALS

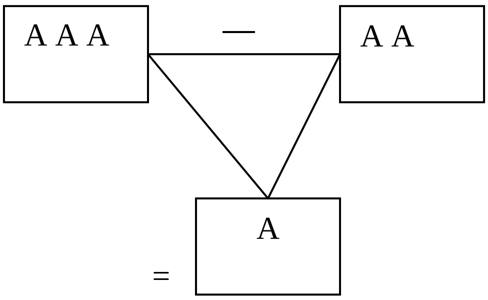
a.



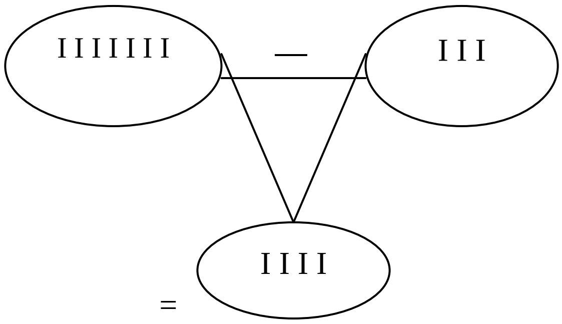
b.



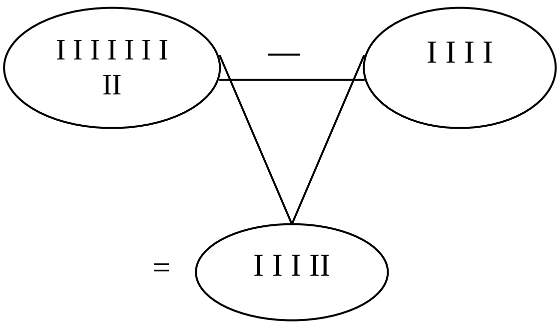
c.



d.



e.



EXPANDED NOTATION WITHOUT CONCRETE MATERIALS

LESSON 2

a. 3 tens - 9 ones = (2 tens + 10 ones) – 9 ones
= 2 tens + (10 ones – 9 ones)
= 2 tens + 1 one

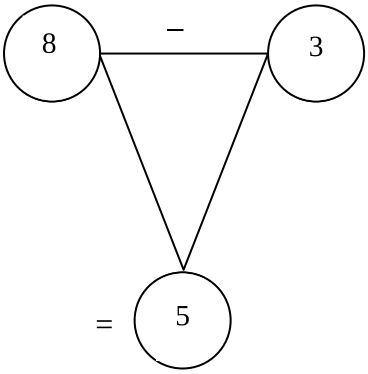
b. 4 tens + 9 ones
- 1ten + 8 ones
3 tens + 1 one

c. 5 tens + 2 ones = (4 tens + 10 ones) + 2 ones
- 3 tens + 8 ones 4 tens + (10 ones + 2 ones)
4 tens + 12 ones
- 3 tens + 8 ones
= 1 ten + 4 ones

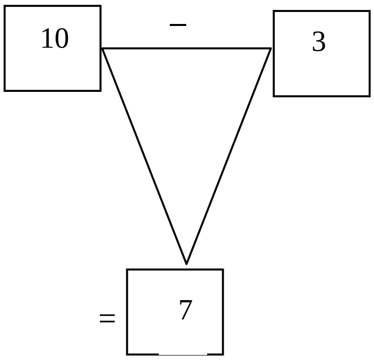
d. 12 tens + 9 ones
- 6 tens + 3 ones
6 tens + 6 ones

CONVENTIONAL NOTATION **LESSON 3**

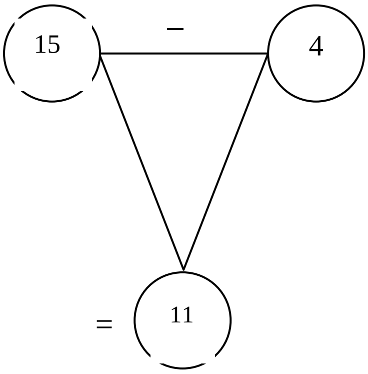
a.



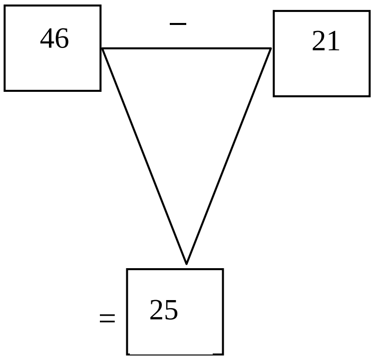
b.



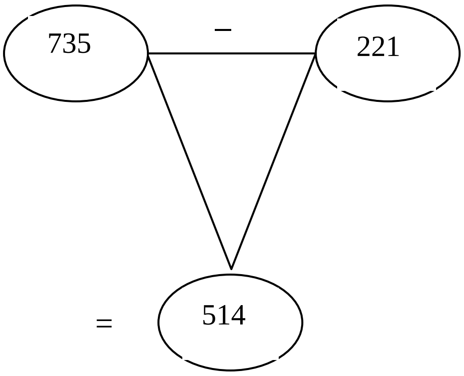
c.



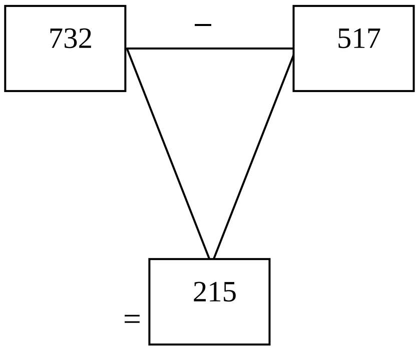
d.



e.



f.



LESSON 4

a.

	T	U
	4	6
-	2	1
	2	5

OR

	T	U
	TENS	**ONES**
	1111	111111
-	11	1
	11	**11111**
	2	**5**

b.

	T	U
	3	2
-	1	3
	1	9

OR

	T	U
	TENS	**ONES**
	11**1** →	(**1111111111**) 11
-	1	111
	1	**111111111**
	1	**9**

c.

	H	T	U
	7	3	2
-	5	1	1
	2	2	1

OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
	1111111	111	11
-	111111	1	1
	11	**11**	**1**
	2	**2**	**1**

d.

	H	T	U
	7	3	2
-	5	1	7
	2	1	5

OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
	1111111	11**1** →	(**1111111111**)11
-	111111	1	1111111
	11	**1**	**11111**
	2	**1**	**5**

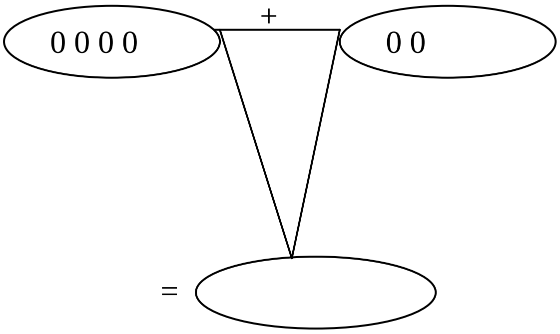
e.

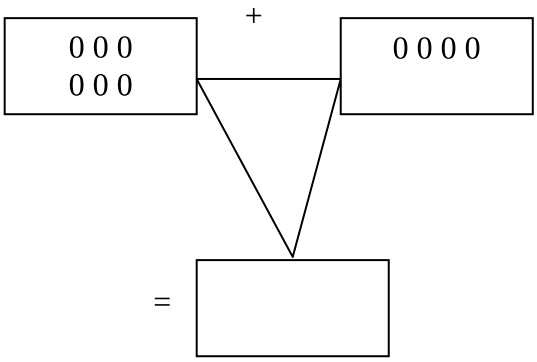
	H	T	U
	5	2	3
-	3	4	1
	1	8	2

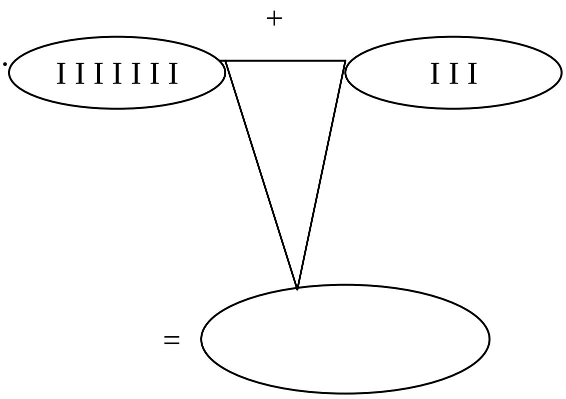
OR

	H	T	U
	HUNDREDS	**TENS**	**ONES**
	1111**1** →	(**1111111111**)11	111
-	111	1111	1
	1	**11111111**	**11**
	1	**8**	**2**

EXERCICES:

1.


2.


3.


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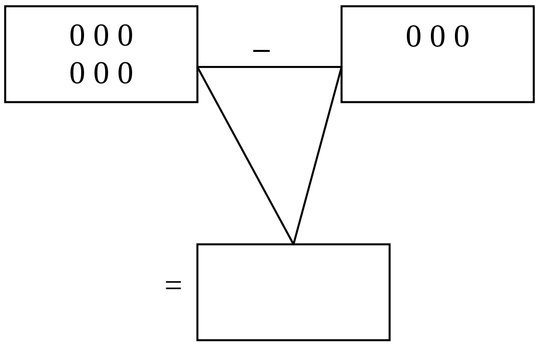

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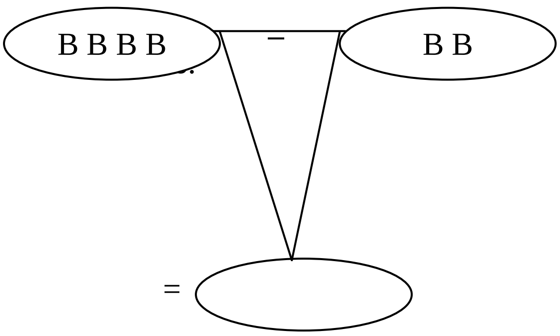

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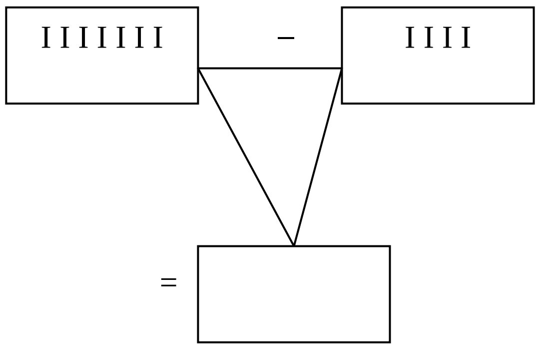


7. 2 tens + 3 ones
+ 3 tens + 2 ones
____

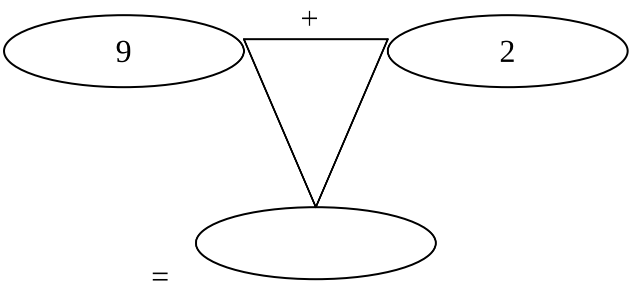
8. 6 tens + 3 ones
+ 7 tens + 2 ones
____

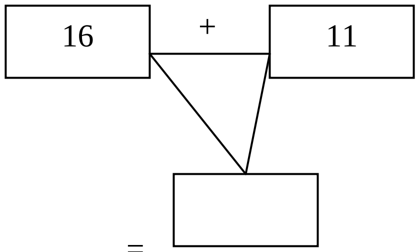
9. 3 tens + 13 ones = 3 tens + (1 ten + 3 ones)
= (3 tens + 1 ten) + 3 ones
= ______________
____

10. 3 tens – 7 ones = (2 tens + 10 ones) – 7 ones
= 2 tens + (10 ones – 7 ones)
= ______________

11. 4 tens + 9 ones
_ 2 tens + 7 ones
____

12. _ 5 tens + 2 ones = (4 tens + 10 ones) + 2ones
3 tens + 8 ones 4 tens + (10 ones + 2ones)
_ 4 tens + 12 ones
3 tens + 8 ones
____

13.


14.


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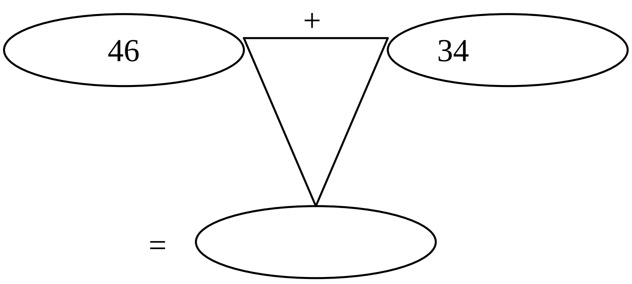

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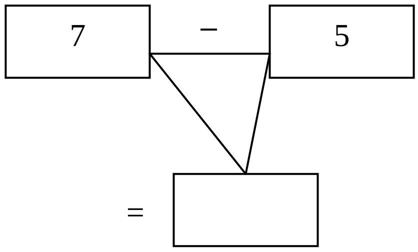
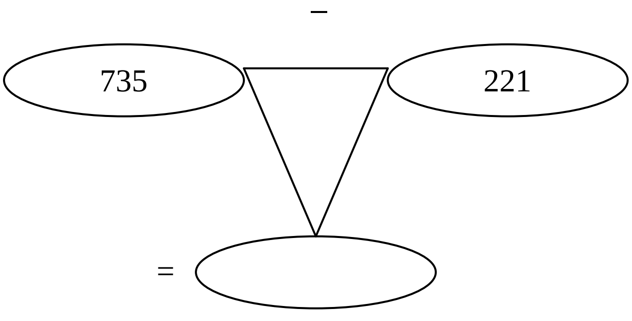
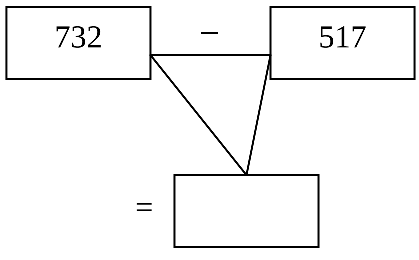


17.


18.


19. T U

4 6

\+ 2 2

____

OR

	T	U
	I I I I	I I I I I I
+	I I	I I
	I I I I I I	**I I I I I I I I**

20. H T U

2 3 4

\+ 1 2 3

____

OR

	H	T	U
	I I	I I I	I I I I
+	I	I I	I I I
	I I I	**I I I I I**	**I I I I I I I**

21. H T U

2 1 9

\+ 3 0 3

____

OR

	H	T	U
	I I	I	I I I I I I I I I
+	I	0	I I I
	I I I I I	**I I**	**I I**

22. T U

4 6

\- 2 1

____

OR

	T	U
	I I I I	I I I I I I
-	I I	I
	I I	**I I I I I**

23. H T U

7 3 2

\- 5 1 1

____

OR

	H	T	U
	I I I I I I I	I I I	I I
-	I I I I I	I	I
	I I	**I I**	**I**

24. H T U

7 3 2

\- 5 1 7

2 1 5

____

OR

	H	T	U
	I I I I I I I	I I I	I I
-	I I I I I	I	I I I I I I I
	I I	**I**	**I I I I I**

25.

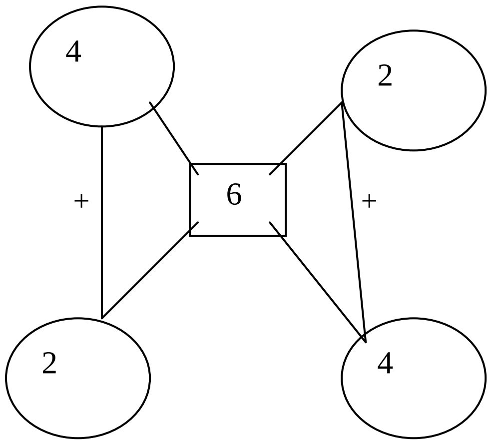
3 + 2 = 2 + 3

5 =

3 + 2 = 2+3

5=

26.



4 + 2 = 2 + 4

6 =

27.

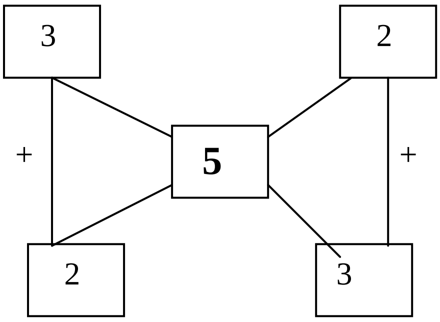
3 + 2 + 4 = 4 + 2 + 3

(3 + 2) + 4 = 4 + (2 + 3)

5 + 4 = 4 + 5

=

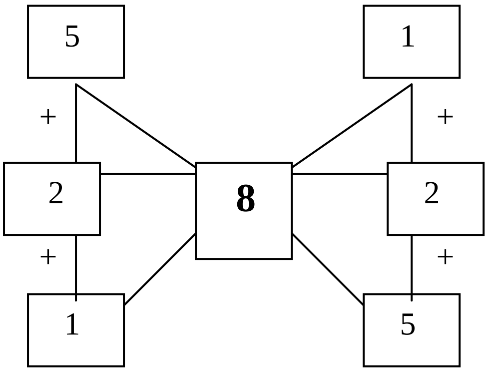
28 COMMUTATIVE PROPERTY OF ADDITION



3 + 2 = 2 + 3

5 = ☐

29. ASSOCIATIVE PROPERTY OF ADDITION



5 + 2 + 1 = 5 + 2 + 1

(5 + 2) + 1 = 5 + (2 + 1)

7 + 1 = 5 + 3

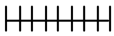
8 = ☐

APPENDIX F

ANSWERS TO LEVEL 2 ACHIEVEMENT TEST

1. ○ ○ ○ ○ ○

2. ○ ○ ○ ○ ○
○ ○ ○ ○ ○

3. 

4. ○ ○ ○

5. BB

6. | | |

7. 5 tens + 5 Ones

8. 13 tens + 5 Ones

9. 4 tens + 3 Ones

10. 2 tens + 3 Ones

11. 2 tens + 2 Ones

12. 1 ten + 4 Ones

13. 11

14. 27

15. 80

16. 2

17. 514

18. 215

19. 68

20. 357

21. 522

22. 25

23. 221

24. 215

25. 5

26. 6

27. 9, 9

28 5

29 8

APPENDIX G

TABLE 3.3 Data

40,43,45,38,39,41,49,30,41,36 36,28,25,40,36,37,42,43,29,30 30,20,25,28,30,40,43,42,43,45 46,30,39,32,33,37,30,38,39,41

TABLE 4.01 Data

Experimental group	Control group
48,47,45,46,40,40,43,42,40,49 49,48,45,47,40,41,48,48,49,46 48,47,45,46,40,40,43,42,40,49 49,48,47,46,44,46,45,48,42,45	44,46,47,40,45,46,39,39,38,48 49,49,44,44,40,42,40,44,46,47 40,45,46,49,39,39,38,47,48,48 40,40,41,42,43,44,40,40,41,43

TABLE 4.04 Data

Experimental group	Control group
44,46,47,40,45,46,49,39,39,38 48,49,49,49,44,44,40,42,40,43 44,46,47,40,45,46,49,39,39,38 49,48,47,46,44,46,48,49,38,38	40,40,41,42,43,44,38,38,39,40 48,49,49,40,44,48,47,48,48,40 40,41,42,43,44,38,38,39,40,48 40,40,41,42,43,44,40,42,41,40

TABLE 4.07 Data

Experimental group	Control group
48,47,45,46,46,46,43,42,46,49 49,48,45,47,40,41,48,48,49,46 48,47,45,46,46,46,43,42,43,49 49,48,47,46,44,46,45,48,42,45	44,46,47,40,45,46,39,39,38,48 49,49,44,44,43,42,40,44,46,47 42,45,46,49,39,39,38,47,48,48 42,42,41,42,43,44,42,42,41,43

TABLE 4.10 Data

Experimental group	Control group
49,49,48,48,46,47,48,40,43,45 49,48,47,46,44,46,49,48,47,48	40,48,49,49,44,44,48,47,48,48 40,40,41,42,43,44,38,38,39,40

TABLE 4.13 Data

Experimental group	Control group
48,47,45,46,40,40,43,42,40,49 49,48,45,47,40,41,48,48,49,46 48,47,45,46,40,40,43,42,40,49 49,48,47,46,44,46,48,46,49,47	48,49,49,49,44,44,40,42,40,43 44,46,47,40,45,46,49,39,39,38 40,48,49,49,44,44,48,47,48,48 40,40,41,42,43,44,41,40,42,40