STUDENTS DIFFICULTIES IN LEARNING ALGEBRA

AT LOWER SECONDARY LEVEL

A

THESIS

BY

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LETTER OF CERTIFICATE

This is to certify that Mr. Kumar Karki, a student of academic year 2069/70 with campus Roll No. 110/2069, Thesis No. 1158, exam Roll No. 281083 (2070) and TU Registration No. 9-2-694-24-2008 has completed his thesis under my supervision during the period prescribed by the rules and regulations of Tribhuvan University, Nepal. The thesis entitled, **"Students Difficulties in Learning Algebra at Lower Secondary Level"** has been prepared based on the results of his investigation conducted during the period of 2016-2017. I, hereby, recommend and forward that his thesis be submitted for the evaluation as the partial requirement to award the Degree of Master Education.

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 (Mr. Abatar Subedi)   (Assot. Prof. Laxmi Narayan Yadav)

 Supervisor   Head

Date: …………………………………

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Letter of Approval

A

Thesis

By

Kumar Karki

Entitled

"Students difficulties in learning algebra at lower secondary level" has
been approved in partial fulfillment of the requirements of Degree of Master of Education.

Committee for viva-voce   **Signature**

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ABSTRACT

This study identified students' difficulties in learning algebra at lower secondary level. This study used a mixed method research design in Quan-Qual form. To fulfill the objectives of this study, the researcher had taken primary data for the achievement test and interview under the difficulties in conceptual area. The test contained questions from five main areas of algebraic difficulties; variables, algebraic expressions, equations, word problems and transition from arithmetic to algebra. After the test, ten students were interviewed to find difficulties in learning algebra.

In this study, 150 students from two secondary schools of Nuwakot district were taken for the sample study purposively. Achievement test and interviews were the tools used in data collection procedure. Data were analyzed by both qualitative and quantitative ways. The mean and percentage result of class-wise as well as overall responses were calculated and drawn the conclusion on the basis of learning disability theories and integrated mixed inferences.

The results indicated a number of difficulties under each area. Some difficulties obtained from misunderstanding and misconception of algebra in which, the main reason for difficulties were the lack of understanding of the basic concept of the variable in different context, solving ways and rules, errors in simplification and guessing without reasoning. The finding of the study concluded that, learning difficulties plays the vital role to obtain the low achievement in algebra.

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Chapter I

INTRODUCTION

Background of the Study

Mathematics is a most important discipline in this world and algebra is a familiar chapter of mathematics. The growth and development of algebra is developed from ancient age. Algebra is one of the oldest branches of mathematics. There is historical evidence that the Babylonians were versed in its 4000 years ago. In 2000 B.C the Babylonians used algebraic methods in solving problems. However, they used no mathematical symbols other then primitive numerals. The history of algebra under consideration provides one with access to different types of algebra to the development of the concept and they have been used over some years now. The types of algebra as: Classical algebra, Symbolic algebra, Modern algebra, Boolean algebra, Linear algebra and School algebra.

School algebra is seen to focus on manipulative skills of simplifying, factoring, solving equations, functions and graphs, variables, word problems, patterns ,inequalities, shapes(area, perimeter and volume) etc. Algebra as a like arithmetic with depends on the mathematical operations of numbers but in algebra in the place of number we uses letters or symbols. Algebra is related to arithmetic and geometry because the problems of algebra can be consider in the figure of geometry and any particular form of arithmetic can be consider in the general form of algebra. At present, algebra is not limited to only mathematics its area is widely large. Thus algebraic reasoning and symbolic notations serve as the basis for the design and use of computer spreadsheet models. Therefore, mathematical reasoning developed through algebra is necessary all through life, affecting decisions we make in many area such as finance, travel, cooking, and other social subjects.

Learning difficulties on mathematics is directly related to the achievement of student in mathematics which is a great challenge to the mathematics teacher. Difficulties in learning algebra for students may directly be related to teacher's mathematical knowledge, use of materials, classroom practices, school management, pre knowledge of students, family education, learning environment and intellectual capacity. This study focuses on student's difficulties on learning algebra at lower secondary level. Egodawatte(2011) carried out the main difficulties on learning algebra as: difficulties in comprehending variables, difficulties in dealing with algebraic expressions, difficulties on solving equations and difficulties in solving word problems. Booth(1988) also identified some of the root causes of students' difficulty in learning algebra as: the algebraic activity to perform, the nature of answers, the use of algebraic notations, and the meaning of letters and variables and J.L. Rejes(2012) discussed about the difficulties on learning algebra as: process related- difficulties and content- related difficulties. So, difficulties on the basis of literature of this study are difficulties on understanding variables, difficulties on algebraic expressions, difficulties on solving simple equations, difficulties on word problems and difficulties on transition from arithmetic to algebra.

From the above discussion, it seems that more students have been facing number of difficulties in learning algebra at lower secondary level. So that in this study, researcher tried to find out the difficulties in learning algebra at lower secondary level with the purpose of explaining some difficulties in learning algebra at lower secondary level.

Statement of the Study

The statement of the problem should be clearly mentioned any kind of research so I have tried to state the statement of the problem related to this study in my own experience. In my experience of teaching at Janajagriti Secondary School

Melamchi-5, Sindhupalchok, and Sundarikeurini Secondary School, Gerkhu-3, Nuwakot and my secondary learning period, I had faced some difficulties in teaching and learning algebra at lower secondary school mathematics. Most of the lower secondary students feel algebra is a more difficult topic than other topics and therefore, I selected this research problem "students difficulties in learning algebra at lower secondary level. So that, this condition being the establishment of important research questions. This study based on the following research questions:

- What are the students' difficulties in learning algebra at lower secondary level?

Objectives of the Study

Objective is a word to present a clearer destination of any study. It fixes the destination to go or to achieve through performance, so that objectives are guideline of the study. In this study, I have taken some objectives which are helpful for new finding about the students' difficulties in learning algebra at lower secondary level. The objective of this study was to find out the students' difficulties in learning algebra at lower secondary level.

Significance of the Study

Significance of the study means the rationale of the study. This study was concerned on the students' difficulties in learning algebra at lower secondary level. Most of the students were weak in algebra because they have no conceptual or structural knowledge of variable, expression, factorization and problem solving way. Thus most of the students did not have clear concept about algebra. The significances of the study were following as:

- The results of this study were helpful for students, teachers, parents, curriculum maker and education administrators.

- It is more helpful for students to identify the contributing factors and effects of difficulties in learning algebra.

- Its finding would help to reduce the difficulties in learning algebra and improve the mathematics achievement.

- It helps to students and teachers for algebraic teaching and learning.

- This study would open the door for the further study about the problem of difficulties in learning algebra at lower secondary level.

Delimitation of the Study

Delimitation of the study determines the boundary of the study area. In this study, the major delimitations were following as:

- This study based on lower secondary level students only government school of Nuwakot district (Sundarikeurini Secondary School and Prithvi Secondary School)

- This study carried only a problem of difficulties in learning algebra at lower secondary level.

- This study completed on the basis of interview and achievement test.

- This result cannot be generalized to other schools' students.

Definition of Related Terms

Lower Secondary Level students

In this study, student means those who are reading at grade 6, 7 and 8.

Difficulties

Difficulty means obstacles or problems faced by student in learning algebra.

Algebra

A branch of mathematics related to variable, manipulating skill of simplifying, solving equation, word problem, expression, shapes etc. Algebra is a one of the broad part of mathematics, together with arithmetic, geometric and analysis.

Learning Difficulties

Learning difficulties means problems or obstacles with students in learning algebra. It means unable to organize mathematical concept with appropriate process and method.

Difficulties in Comprehending Variables

Difficulties in comprehending variables mean problems in understanding of variable, unable to define the meaning of variable and unable to differentiate the variable and constant properly.

Difficulties in Dealing with Algebraic Expression

Difficulties in dealing with algebraic expression means problem in understanding the meaning of letters in the context of algebra and confusion to solve algebraic expression with proper mathematical operation.

Difficulties in Solving Equation

Difficulties in solving equations mean problems in the application of rules and procedures of simplifying equation.

Difficulties in Word Problem

It means problem in vocabulary, language and translating word problem in algebraic statement, and problem in reading, writing and speaking the term of mathematics properly.

Difficulties in Transition from Arithmetic to Algebra

Difficulties in transition from arithmetic to algebra means student having unclear understandings from arithmetic thinking to algebraic thinking.

Achievement Test

In this study, achievement test means a test conducted at grade 6, 7, and 8 students to observe their achievement.

Chapter II

REVIEW OF RELATED LITERATURES

The chapter deals with the review of the related literature to the study, it determined what to be done in the concern area of the research topic .Review of literature would help to us for introducing the problem, significant of the study, to select the suitable research design, method, to determine the process of data collection and analysis clearly. It helps to conduct the research in proper manner and gives the better idea to study as well as gain the information about related literature. The previous studies could not be ignored because they provided the foundation to the present study. So that researcher reviewed some literatures which are given below;

Empirical Literature

The review of empirical literature of the study was very important and necessary. If researcher didn't review this literature then the researcher can't proceed ahead and can't be clear about the research way, concept, design and analysis process. It provides the psychological, sociological, philosophical, contextual, historical knowledge, concept and traditional way of study. From it, researcher gains pre-knowledge of study, pre- techniques, pre- methods and pre- analysis procedures. So, researcher reviewed the following literatures:

Sharma (2009) did study "An error analysis in solving algebraic problems of grade five students". The objectives of this study was to find the errors made by students in solving problem of simplification and equations of algebra and to compare the error made by students in knowledge, skill, and application and problem solving of simplification. This research was qualitative in nature and it was based on descriptive design. The sample of this study was Janata Primary School of Surkhet and all 30 students of grade V were selected. Interview schedules were the main tool

of this study. Major findings were as: 75% of error occurred at the comprehension and transmission stage, 12% error occurred at the process skill stage, 5% errors occurred at encoding stage, 8% errors occurred at due to careless of student and 40%, 34%, and 26% errors on knowledge level, skill and application level and problem solving level. The study concludes that poor performance of students in the topics simplification and equations in different areas such as knowledge, skill, application and problem solving.

Chaudhary (2013) Studied on "Teachers' belief on teaching algebra and their classroom practices" with the main objectives was to investigate teachers' belief on teaching algebra, to compare the belief of rural and urban teachers, to compare the beliefs of experienced and inexperienced teacher about teaching algebra. This study was survey design as well as quantitative in nature and the sample of this study was 25 public lower secondary, secondary and higher secondary school of Bara district from 13 were rural and 12 were urban area by quota sampling. Opionnaire collection was data collection procedure and Likert scale was analysis procedure. The major finding was 55% of the statements were agreed by the teacher, 35% were disagreed and 10% were undecided and the beliefs of the teacher in rural versus urban shows no statistically difference. The study concludes that it were important for the mathematics teachers to attain a proper understanding of algebra.

Poudel (2014) studied on "difficulties in learning trigonometry" The objectives of this study was to find the causes of difficulties in learning trigonometry and to minimize the difficulties in learning trigonometry at secondary level. One public and one private school were selected for the sample and the design was qualitative in the nature. The data collection tools were interview and classroom observation. The study concludes that there were not sufficient materials for learning trigonometry and due to the lack of interactive classroom students feels difficulties in learning trigonometry.

The above review of related literature shows that an error in solving algebraic problems, poor performance of simplification, equations and problem solving. Teacher beliefs on teaching algebra were important for the mathematics teacher to attain a poor understanding of algebra and there were not sufficient materials for learning trigonometry and lack of interactive class room.

Gautam (2016) did study on "difficulties in learning vector geometry at secondary level". The objectives were to explore the different kinds of difficulties in learning vector geometry at secondary level and to find out the way for minimizing the difficulties in learning vector geometry at secondary level. This study was qualitative descriptive study and the sample of this study was Mulpani higher secondary school in which seven students, teachers, and head teacher were selected from Baglung district. In - depth interview, observation. Test was the data collection tools of this study. Data analyzed by applying different logical ways. The major findings were most of the students have distraction during the vector geometry tasks, they make error because they misread magnitude incorrectly without caring direction and students did not do sufficient practice of vector geometry at home due the poor concept and understanding as well as there was lack of motivation and encouragement about vector geometry in the class. This study concludes state made both teacher and students' a passive agent in dealing with vector geometry teaching and learning and continuous assessment system should be taken in practice.

Poudel (2008) studied on "Difficulties in learning mathematics". The main objectives were to identify the difficulties in learning mathematics of stone quarries students at school and to find out the cause of difficulties in learning mathematics of stone carries students at school level. This study was qualitative in nature and five stone quarries students at lower secondary level were selected from four public

schools in Kathmandu district at near to Chovar V.D.C. The instruments of this study were interview and observation. Major finding was there is no sufficient time for mathematics learning at home for stone quarries students and there is discontinuity between practices of mathematical concepts in school and home. It concludes that the learning environment at home and school, that creates the difficulties in mathematics learning.

Dhital (2016) did study on "Learning difficulties of students in secondary school mathematics". The objectives of this study were to identify topics perceived difficult by students in secondary school mathematics, to determine if there exists any significant relationship between perceived and actual learning difficulties in secondary school mathematics and to determine if there exists any difference in student's actual learning difference across gender. This study was quantitative in the nature and 240 secondary students (120boys and 120 girls) were selected from Rautahat district by Stratified random sampling. Questionnaire was the major tool for the study and survey form was data collection procedure. Data analysis procedure were mean, percentage ,standard deviation and two tail t- test at 0.05 level of significance .There was a negative significant relationship between the perceived and actual learning difficulties of students is major finding and it concludes that the achievement of boys students is better than that of girls students.

The review of above literature researcher found that teachers and students were a passive agent in dealing with vector geometry teaching and learning, there were no sufficient time for mathematics learning at home for stone quarries students and achievement of boy students were better than that of girl's students in mathematics.

Reyes (2012) studied on "Equal or Not? An exploration of 8- grade students experience of algebra". The research questions were how do eight- grade students perceive algebra and the eight - grade mathematics curriculum and what difficulties, if any, students encounter in learning algebra. The research was qualitative in the nature and ten students, teacher of Leader middle school of Georgia were selected. Interview was the main instrument of this study and data analyzed using the constant comparative method. The finding of this study was providing several opportunities of the areas curriculum and pedagogy for improving students experience and it concludes that participants offered great insight into the difficulties with algebra that are experienced by many eight- grade students.

Tahir (2008) studied on "Teaching and learning algebra in the junior secondary years". The main aim of the study was does the multi-faced variable approach lead a deeper conception of variable by student than the traditional approach to teaching algebra in years 7- 8.The design of the study was quasi- experimental nature and seven metropolitan higher school in Sydney were selected on the basis of 54 students in comparison group and 49 students in experimental group and teachers. Interview and questionnaire were the main instruments. The finding were students of the experimental classes demonstrated a deeper understanding of the variable concept compared to the comparison classes and it concludes that the study has provided evidence that it is possible to minimize students misconceptions by using the MVA in algebra course in years 7-8.

Egodawatte (2011) studied on "Secondary school students' misconception in algebra". The major research questions were what are the secondary school students categories of errors and misconception in solving problems related to variables and what are secondary school students categories of errors and misconceptions in solving

problems related to algebraic expression and in solving equations. The design of the study was in mixed nature and the sample was selected from grade 11 students in an urban secondary school in Ontario. Interview, case study and algebraic test were the main instruments to this study and qualitative analysis and quantitative analysis were used for data analysis. This study concludes that the difficulty of directly accessing student's mathematical thinking and reasoning behind their action and misapply rules or procedure which are inappropriate in certain algebraic solution.

Moreover on the basis of above study the researcher found that providing several opportunities of the areas curriculum and pedagogy for improving students experience, possible to minimize students misconceptions by using the MVA in algebra course in years 7- 8 and the difficulties of directly accessing student's mathematical thinking and reasoning behind their action and misapply rules or procedure which are inappropriate in certain algebraic solution.

Theoretical Literature

This chapter reviews the literature about the educational or psychological learning theory which is provided the theoretical foundation to this study and discussed the theoretical framework of the study on students' difficulties in learning algebra. The theoretical framework supported to fulfill the research questions and the significance of the study. There were many learning theories related to mathematics and learning mathematics. They are behaviorist theory, cognitive theory, social constructivist theory, structural functionalist theory, cultural language theory, learning disability theory, learning disorder theory and so on. Among them the researcher used learning disability theory and discuss below:

Learning Disability Theory

Learning disability theory is directly related to the learning difficulties.

Learning disability is a general term that describes specific kinds of learning problem. A learning disability can cause a person to have trouble learning and using certain skills. The skills most often affected are reading, writing, listening, speaking, reasoning, and doing mathematics. Learning disability is a classification including several areas of functioning in which a person has difficulty learning in typical manner, usually case by unknown factor or factors. Given the "difficulty learning in typical manner" this does not exclude the ability to learn in different manner. Therefore, dome people can be more accurately described as having a "Learning Difficulties", thus avoiding any misconception of being disabled with a lack of ability to learn and possible negative stereotyping. While learning disability, learning disorder and learning difficulty are often used interchangeably, they differ in ways. Disorder refers to significant learning problems in an academic area. These problems, however, are not enough to warrant an official diagnosis. There are different types of learning disability, they are:

Language Based Learning Disability

LBLD are heterogeneous disorder associated with young children that affect their academic skills such as listening, reasoning, speaking, reading, writing and math calculations.

Social Model of Disability

This ability assured that there are social or structural causes of disability.

Medical Model of Disability

This ability is perceived as an individual deficit that is biological in origin.

Nonverbal Learning Disability

This ability deals the poor visual spatial skills, problematic social relationship, difficulty with mathematics and poor organization skills.

Mathematics Learning Disability

In this disability involves difficulties such as learning math concepts, difficulty memorizing math facts, difficulty organizing number and understanding how problem are organized. (en. wikipedia.org/wiki/ Learning disability)

The Individuals With Disabilities Emprevement Act (IDEA 2004): learning disability means a disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which disorder may manifest itself in the important ability to listen, think, speak, read, write, spell or do mathematical calculation.

Mathematics learning disability not often occurs with clarity and simplicity. Rather, they can be combinations of difficulties which may include language processing problems, visual spatial confusion, memory and sequence difficulties and unusually high anxiety. With the awareness that math understanding is actively constructed by each learner, we can intervene in this process to advocate for or provide experience with manipulative, time for accurate language, access to helpful technologies, understanding and support. So learning disability is becoming a burning challenging of the learning mathematics at the present in every level. Every stakeholders of education realize this problem at a time and necessary to solve this problem with appropriate strategies.

Conceptual Framework of the Study

Conceptual framework of the study deals about the concept of possible area of this study. In this study researcher tried to find out the student's difficulties in learning algebra at lower secondary level on the basis of above empirical and theoretical literature. The conceptual framework has been designed to fulfill the objective of this

study on the basis of students' difficulties in learning algebra. The students' difficulties in learning algebra at lower secondary level were following as:

Difficulties in Comprehending Variables

Letters represent different meaning in different contexts. When letters are present in algebra entitles, this is a seeming difficulty for students. A letter that represents more than one number or value is called variable. The understanding of letters in different context is more difficult.

Difficulties in Dealing with Algebraic Expression

Letters are used to build up an algebraic expression. Either one letter or combination of letters could be used in an expression. Therefore, there is a close relationship of understanding the meaning of letters in the context of algebraic expressions. There are many difficulties in an expressions like: addition, subtraction, closure and distributive property, change verbal problem into mathematical algebraic statement and so on.

Difficulties in Solving Equation

When two algebraic expressions combine together with an equal sign, it is called an equation. To solve an equation, one most known difficulty was the application of rules of simplifying equation on the basis of given question. Also use of equal to signs and understanding of equation solving method were difficult.

Difficulties in World Problem

Students in solving algebraic word problem, translating the mathematical statement into appropriate algebraic expressions was more difficulty for students within assigning variable, noting constant and representing relationships among variables. Word problems were related to language, vocabulary, mathematical terminology and mathematical rules.

Difficulties in Transition from Arithmetic to Algebra

Transition from arithmetic to algebra means the transition from about a known quantity to thinking about an unknown quantity as the transition from arithmetic thinking to algebraic thinking. So moving from arithmetic to algebraic problem solving is difficult for students. They cannot clear about an arithmetic strategy to solve algebraic problem.

The figure of conceptual framework of this study is drawn below:
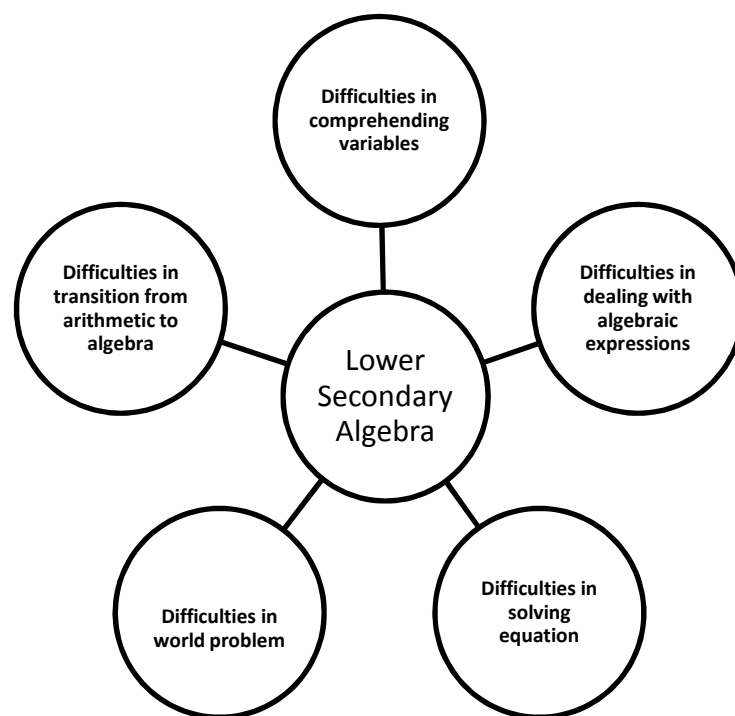
Source: Egodawatte, G.(2011) and Tahir (2008)

This conceptual framework describes about the lower secondary school students difficulties in learning algebra. On the basis of above framework comprehending variable, algebraic expression, solving equation, word problem, and transition from arithmetic to algebra were the main five difficulties area in lower secondary level mathematics. These difficulties were faced by many students at lower secondary level whose impact is directly related to the students' achievement in mathematics.

Chapter III

METHODS AND PROCEDURES

This chapter contains the methods and procedures which is helpful to be obtained the objectives of study and to get answer of the statement of the difficulties. In which methods means technique and procedures means the process of data gathering and analyzing. It describes the design of the study, population and the sample, data collection tools, reliability and validity of tools, data collection procedure and data analysis procedure.

Design of the Study

This study was based on a mixed method approach using concurrent design with quan- qual form. A mixed method study both qualitative and quantitative research methodologies. Concurrent design is selected when researcher uses two different methods in an attempt to confirm, cross- validate or coroborate finding within a single study. In this method, the qualitative and quantitative data collection is concurrent, happening during one phase of study. Creswell and p. Clark (2007): triangulation is a single phage design requiring the researcher to incorporate quantitative and qualitative methods within the same timeframe while maintaining equal weight. Concurrent mixed methods "are those in which the researcher converges or merges quantitative and qualitative data in order to provide comprehensive analysis of the research problem" (Creswell, 2009 p. 228).

Population and Sample

The population of this study was all the lower secondary level students of Nuwakot district. So, the sample of the study was (Shree Sundarikeurini Secondary School and Shree Prithvi Secondary School) of Nuwakot with purposive sampling and only 150 students of grade 6, 7 and 8 in which 47 students of grade 6, 53 students

of grade 7 and 50 students of grade 8 had been selected for this study and ten students were selected for interview.

Data Collection Tools

Since the design of the study was mixed method with concurrent design in quan- qual form so that the researcher collected the data using primary sources on the basis of quantitative and qualitative nature and uses the secondary data if necessary. In this study the tools as interview and achievement test for students to fulfill by themselves were used and collected the necessary primary data or information.

Interview

Interview is a process of communication in which the interviewee gives the needed information verbally in face to face situation. It is a method of gathering information by talk, discussion or direct question. In interview, the interviewer asks a person being interviewed, the respondent, and question design to obtain answer to the research problem. The researcher took the interview to fulfill the objective of study. The interview guidelines were designed on the area of comprehending variables, algebraic expression, solving equation, word problem and transition from arithmetic to algebra. In this study, researcher used interview guidelines with respondents on the basis of Appendix- F.

Achievement test

Achievement test was an important tool in this study to collect the data and measures the knowledge, skill and mathematical ability of students related to the difficulties of conceptual framework. It is widely used to evaluate the student standards and achievement. By the help of achievement test researcher found the students difficulties in learning algebra. In this achievement test 150 students were selected and 20 multiple choice questions were constructed (Appendix- A). After that,

researcher selected 10 students for interview from each difficulties area. The main theme of these tools in this study was to find out the students difficulties in learning algebra at lower secondary level.

Reliability and Validity of Tools

To obtain reliability and validity of the tools researcher made guideline for interview and questionnaire of achievement test using different theories and reviewed literature. Achievement test was conducted on the basis of the learning difficulties areas, questionnaires are organized in simple to complex form with guideline and find out the learning difficulties area in algebra. After that containing all the difficulties area, the interview was conducted. By the regular help of supervisor, the questions were removed or added if necessary. The researcher tried to collect the data from different difficulties area of conceptual framework with different sources by using different tools as well as analyzed in qualitative and quantitative ways. Class-wise incorrect and correct response percentages, and overall response percentages were analyzed to obtain reliability and validity.

Data Collection Procedure

This study was related to the lower secondary level of Sundarikeurini Secondary School and Shree Prithvi Secondary School of Nuwakot district. The researcher went to this school with the above tools as achievement test and interview to collect the quantitative and qualitative data. Researcher conducted the achievement test at lower secondary and 150 students were selected, and find out the difficulties area related to the teaching and learning activities in algebra. In this period every notable activity were collected. Researcher took interviews with ten students by using the interview guideline and responses were noted carefully as well as conducted the achievement test properly**.**

Data Analysis Procedure

Since the study was mixed method in concurrent design with quan- qual form. So the researcher were analyzed the data by using the qualitative and quantitative analysis procedures. In quantitative data analysis procedure the data were collected by using the tool as achievement test and find out the difficulty area within the primary sources in this study. In quantitative data, statistical analysis were performed on the background of achievement test using descriptive statistics like mean, percentage and uses other method if necessary. After that in qualitative data analysis procedure the data were collected by using the tool as interview including 10 students within the different difficulty area and analyzed the data on the basis of triangulation approach. In this study class wise response percentages and overall percentages were analyzed on the basis of achievement test as well as the main themes were analyzed by the help of learning disability theories. At last, data were analyzed on the basis of integrated mixed inferences.

Chapter IV

DATA ANALYSIS AND INTERPRETATION OF RESULTS

This chapter provides an overall analysis and interpretation of students' difficulties in learning algebra at grade 6, 7, and 8. This was a concurrent mixed method study in quan- qual form of students' difficulties in learning algebra at Shree Sundarikeurini Secondary School and Shree Prithvi Secondary school of Nuwakot district purposively. The objective of this study was to find out the students difficulties in learning algebra at lower secondary level. The researcher used achievement test as quantitative tool and in- depth interview as qualitative tool to collect the data.

This chapter includes the analysis of data and interpretation of the result obtained from the primary sources. At first, data was collected from the quantitative process on the basis of achievement test and analyzed the data by the help of descriptive statistics mean and percentage to obtain the main difficulties area of this study properly. The major areas of difficulty were comprehending variable, dealing with algebraic expressions, solving equations, word problems and transmission from arithmetic to algebra which are mentioned in conceptual framework. The data was taken on the basis of above difficulty areas. After that the researcher found out the major difficulty areas of students' difficulties in learning algebra and took interview (Appendix- F) with the students. The researcher selected ten students for interview including two students from each difficulties area. Those students were among the total incorrect respondent of each difficulties area.

The data were analyzed and interpreted from the information taken on the basis of achievement test and students' interview including qualitative and

quantitative procedures and the researcher combined the findings in a final interpretation or integrated mixed inferences.

In this chapter, the researcher presents the result of analysis on the basis of interpretation of the data. As a first step, percentages of difficulty for each conceptual area were calculated. There were two steps to this process. First, over all percentage (Appendix-D) number of responses for each student's under each conceptual area was calculated. Second, class-wise percentage (Appendix-C) of student's under each conceptual area was calculated and then interview was taken.

To analyze and interpret the difficulties area the researcher discussed the achievement test about algebra. In this achievement test 150 students (Shree Sundarikeurini Secondary School and Shree Prithvi Secondary School) were selected from Nuwakot district and twenty (20) multiple choice questions with four distracters (one correct lettered a- d) were constructed on the basis of five difficulties areas (Appendix-A). The composition of the questions were illustrated in Appendix- B in which comprehending variable contains three questions, algebraic expressions contains five questions, solving equation contains four questions, word problem contains four questions and transmission from arithmetic to algebra contains last four questions. The actual mean of this test was only 8.96 which is less than assumed mean 10. This shows that there a significant different between actual mean and assumed mean. After that class-wise response percentages (Appendix- C) and overall or detailed response percentages (Appendix- D) were calculated. The collected data was analyzed and interpreted on the areas such as difficulties in comprehending variables, difficulties in dealing with algebraic expressions, difficulties in solving equation, difficulties in world problem and difficulties in transition from arithmetic to algebra:

Difficulties in Comprehending Variables

Difficulties in comprehending variable means problem in knowing the meaning of variable correctly, problem in identify the variables and constant and problem to provide the examples of variable. To analyze variable, three questions (Q. No. 1, 2 and 3- Appendix- A) were constructed. Class- wise incorrect and correct response percentages (Appendix- C) shows 21.28%, 22.64% and 22% students of grade 6, 7 and 8 responded incorrect answer and only 4.25%, 9.43% and 8% responded to correct answer. Detailed or overall response percentages of each area (Appendix- D) shows 22% of total students responded to all incorrect answer, 7.33% students responded to all correct answer, 54.6% students responded to one correct answer and 16% students responded to two correct answers. This result indicates that comprehending variable was more difficult to students and feels more problematic topic. They couldn't solve the problem related to the variables. So that students felt it is very difficult.

The researcher asked the question with students "what is variable? Can you differentiate variable and constant? Can you say the examples of variable? What are the causes of feeling difficulty in variable? Then students said that:

"I have heard and studied about the word variable, but at this moment I couldn't define it properly, but I know variables are used in algebra and we can find some value of it. I am confused to differentiate between the variable and constant and have misunderstanding about the meaning of variable". (Grade 6 student view)

"I think variable is useful in algebra but I don't know the meaning of variable. I couldn't say the example of variable and I can't identify the variable or constant in exercise while I am solving the exercises". (Grade 7 student view)

This shows that the comprehending variable was more difficult for student. The above students' views show that the students were feeling uneasy and confused with the comprehending variable. They couldn't know the concept of variable and constant promptly. They couldn't differentiate the statement of variable and constant and they couldn't provide right example of variable and constant. The students show less understanding level of knowledge in the study of variable and constant. Thus this was the most difficult topic in algebra at grade 6 and 7. The symbols in algebra have different meaning and interpretations in different situations. Students have incorrect and incomplete perceptions about the letters, numbers and signs. The overall image that emerged from the findings was that students have difficulties in understanding various uses of letters and signs in different situations. The learning disability theory with language based learning disability associated with students that affected their skills such as listening, reasoning, speaking, reading, and writing. But researcher found that misunderstanding of the concept of variables creates difficulties on it, so that lack of understanding of variable is main problem on it.

Difficulties in Dealing with Algebraic Expression

Difficulties in dealing with algebraic expression means problem to define algebraic expression, problem in providing the example of algebraic expression, problem in solving the algebraic expression, and problem with basic mathematical operational skills. For algebraic expression, five questions (Q. No. 4, 5, 6, 7, and 8, Appendix- A) were illustrated. The researcher analyzed the class-wise and overall response percentage. Class- wise incorrect and correct response percentages (Appendix- C) shows 10.6%, 11.3% and 14.7% students of grade 6, 7 and 8 responded incorrect answer and only 8.51%, 13.20% and 16% responded to correct answer. Similarly, in detailed or overall response percentages of each area (Appendix-

D) shows 10.66% of total students responded to all incorrect answer, 12.67% students responded to all correct answer, 31.33% students responded to one correct answer, 17.33% students responded to two correct answers,16% students responded to three correct answer and 12% students responded to four correct answer. This analysis shows that algebraic expression was more difficult to students and feels confused to solve this problem, which was the most common problem that arises to students and has significant role in making simple error and makes learning difficult.

Researcher raised the questions to the students and tried to get the answers. The questions were "can you define the term algebraic expression? Give an example of algebraic expression, what do you mean by binomial expression? Can you say the types of algebraic expression? Can you solve algebraic expression properly? What do you feel the most difficult while solving algebraic expression? What are you confused about the operation in algebraic expression?" The answers provided by some students were listed as below:

"As far as I know the algebraic expression is a combination of letters and numbers in a relation. I can identify the types of algebraic expression but I feel doubt in solving the operations like addition, subtraction, multiplication and division of algebraic expression especially with the power used in the relation. Even if I solve the expression, the result is either incomplete or oversimplified". (Grade 8 student view)

"I do not know the meaning of algebraic expression and its types. Actually, I feel hard to solve the algebraic problems. I do not know the rule of their operations and simplification. Since I feel this topic quite hard, I am not interested to practice it often. While studying in class, we had less use of study materials and the solving technique was more difficult so I have problem in learning algebraic expression. (Grade 6 student view)

The above study shows that dealing with algebraic expression was also difficult problem for students, its operation become more complex to understand and solve. The most common problem was to simplify the expression with addition, subtraction, multiplication and division. The students also felt problem to state the types of expression as well as to define them. Some of the students couldn't solve the problem while others try to solve but the result was incomplete or oversimplified. This shows that algebraic expressions were difficult and confusing to solve. Booth (1988) explained the difficulty in accepting the lack of closure property of algebraic letters. Students perceive open algebraic expression as incomplete and try to finish then by oversimplifying. For example, they consider and answer such as a + b as incomplete and try to simplify it to ab.

In algebraic expressions, students' problems increased due to their lack of understanding of the basic concept of the variable. To understand algebraic expressions, students should have a good understanding of the structure and properties of algebra. This is because many algebraic expressions are made of letters and signs and most often they do not involve words. Students made many mistakes during the symbol manipulate stage. Students misapply rules or procedures which are in-appropriate in certain situations and thus the problems were related to mathematical learning disability theory which includes difficulties as learning mathematics concepts, difficulties organizing number and understanding how problem are organized.

Difficulties in Solving Equation

Difficulties in solving equation refer to the problem in solving equation with proper rules and method, incomplete solution, oversimplification and providing answers on guess without reasoning. To analyze solving equation, four questions (Q.

No. 9, 10, 11 and 12, Appendix-A) were designed. The researcher analyzed class-wise and overall responses percentage. Class- wise incorrect and correct response percentages (Appendix- C) shows 19%, 11.3% and 10% students of grade 6, 7 and 8 responded incorrect answer and only 10.6%, 11.32% and 20% responded to correct answer. Similarly, in detailed or overall response percentages of each area (Appendix-D) shows 13.33% of total students responded to all incorrect answer, 14% students responded to all correct answer, 30.67% students responded to one correct answer, 32% students responded to two correct answers and 10% students responded to three correct answer. This result indicates that solving equations were problematic for students and they felt difficult to solve the equation.

The researcher designed few question to interview students to get their views related to the problems on solving equation. The questions were, "what do you understand by linear system of equation? How can you solve the linear equation? What are the problems you face to solve equation? Can you substitute the values and simplify properly?" Then their answers were as listed.

"*Equation means mathematical relation with equality sign but I don't know the meaning of linear equation. To solve equation, I do not have enough knowledge and skill of rules and methods like subtraction, multiplication and division. I am always confused to use mathematical operation about where to add, where to subtract, where to multiply or divide and have no idea of change-side, change sign rule and I solved the equation by guessing*". (Grade 6 student view)

"*In my view, Linear equation means the mathematical relation using variable and constant in a relation with first degree. I try to solve these relations by guessing only but I don't have good skill to solve by elimination, substitution or graphical method. I am confused to choose suitable method and sometimes I make mistakes in making*

simple simplification as well. When I solve the equation, I left the equation half solved or over solved". (Grade 8 student view)

The above study shows that solving equation was very difficult for students because most of the students were unable to solve the problem related to the solving equation. On the basis of interview, students couldn't solve equation properly. They were unable to solve equation by using rules and methods. They have problem in understanding of relations in equation and provided guessing answer. It was difficult for the students to overcome the methods that they have used for solving equation with one variable. This may be because of students' additional difficulties in operating with the unknown linear equation representing in two unknown linear system than operating with a single variable equation (Filloy et al., 2007). Another difficulty was to solve equation and find out the conclusion. It was difficult for them to deduce whether the solution was the same in the two solving methods and the common mistake in solving equation was misuse of "change-side change sign" rule. Sometimes, students forgot to change the sign when they carry over terms to the other side of the equation or apply wrong operation to the terms. The students also had problem with the simplification rule which resulted their operation to incomplete or sometimes to the oversimplified stages.

Solving equation, were inter-related to the two conceptual areas variables and algebraic expression. Some other problems were the reasons of misconceptions. The misuse of equal sign out of its accepted meaning was obvious. Students had problem with understanding the given relationships and build up equation. They often misused the elimination and substitution method. They had some difficulties about the solution of a linear system. Looking back at the solving procedures, verifying the solutions and using other processes were also missing in many situations. These problems related to

the mathematical disability theory and this theory indicated the problem in manipulation of algebraic problem with rules, procedures and methods.

Difficulties in Word Problem

Difficulties in word problem indicate the problem of misreading and misunderstanding of given statement, incorrect reasoning, translating algebraic word problems that state relationships between two or more variables into a symbolic forms. It also deals with the difficulties relation to the mathematical vocabulary and translating them to the relation using proper sign and symbol. For this, the researcher designed four questions (Q. No. 13, 14, 15 and 16, Appendix- A) in which students had to read the problems, convert them into algebraic forms and solve them. The researcher analyzed class-wise and overall response percentages. The class-wise response percentage shows that 23.4% of Grade 6 students, 13% of Grade 7 and 12% of Grade 8 students responded to all incorrect answer while 6.38% of Grade 6, 9.43% of Grade 7 and 8% of Grade 8 students responded to all correct answer (Appendix- C). The overall response shows that 16% students responded to incorrect answer and only 8% students responded to all correct answer. Likewise 26.67% responded to one correct answer, 33.33% responded to two correct answers and 20% responded to three correct answers (Appendix- D). This result shows that solving word problem was also a major problem for students.

The researcher planned some questions to interview students to collect their opinion about word problem. The sample questions were, "what do you mean by word problem? Can you translate the word problem into mathematical statement with proper sign and symbol? Do you have any problem in language, vocabulary or terminology in algebra? Why do you feel word problem more difficult in

mathematics? What are the problems in solving word problem?" The answers provided by some of the students were as below:

"Teacher has to encourage and clarify every vocabulary terms and terminology but my vocabulary is not strong and I am always confused on it. I have no any idea how to translate the word problem into mathematical statement and I have problem in solving word problems by using proper sign and symbol". (Grade 6 student view)

"I have not given sufficient time for mathematics as well as algebra, so it is difficult for me to learn and feel its language, terms, symbols, relation etc which are very problematic and thus my vocabulary is very weak. I do not solve word problem and can not translate word problem with proper manner. When I solve word problem the result is either incomplete or fault, otherwise solve it by guessing without reasoning and understood it in my own language". (Grade 7 student view)

The above study shows that "Word problem" was the most problematic and difficulties area for students. They had difficulties in managing the details of a problem given in a word format. In solving a word problem, students had to pass through various stages. These stages were deciphering the problem given in language, translating it into mathematical form, solving it and interpreting the results. Since a word problem contain concepts related to one or more the areas variables, expressions and equations, this is one of the reasons that word problems were harder for students. Sometimes, there was no visible clear- cut methods to solve word problems. Lack of reasoning skills and methods arriving at an incorrect answer and students faced problems in vocabulary and terminology. In this word problem students' attempts were to match the word in order in own natural language with letters. Misunderstanding and guessing of proportional reasoning led them to arrive at faulty solution. Understanding the problem and translating were two of their major

problems. When they could not understand the word problems properly, students

resorted mostly to guessing procedures and results were either incomplete or fault. In

this word problem language, vocabulary and algebraic terminology were the major

difficulties so that this problems were related to the language based learning

disability.

Difficulties in Transition from Arithmetic to Algebra

Difficulties in transition from arithmetic to algebra means the nature of

problems presented in arithmetic and algebra and the different arithmetic and

algebraic procedures used to solve these problems, problem in moving from

arithmetic to algebraic strategy for solving linear equation and algebraic expression

by using the arithmetic rules, problem in substitute the given value in the

corresponding expressions, lack of knowledge about using arithmetic rules in algebra

properly and problem in generalization of arithmetic rules in algebra. The problem of

transition from thinking about a known quantity to thinking about an unknown

quantity as the transition from arithmetic thinking to algebraic thinking and claim that

transition is difficult for students (Stacey1999).

For this analysis the researcher designed four questions (Q. No. 17, 18, 19 and

20, Appendix- A) in which the students had to read the questions and provide their

response. The researcher analyzed class-wise and overall response percentages. The

class-wise response percentage shows that 8.51% of Grade 6 students, 11.32% of

Grade 7 and 10% of Grade 8 students responded to all incorrect answer while 14.89%

of Grade 6, 15.09% of Grade 7 and 20% of Grade 8 students responded to all correct

answer (Appendix- C). The overall response shows that 10% students responded to

incorrect answer and only 16.67% students responded to all correct answer. Likewise

29.33% responded to one correct answer, 19.33% responded to two correct answers

and 22.67% responded to three correct answers (Appendix- D). This result shows that transition from arithmetic to algebra is also a problem for students to solve the problem correctly.

The researcher constructed few question to interview students to get their views and problems on transition from arithmetic to algebra. The questions were, "what do you mean by transition from arithmetic to algebra? What are the problems to use arithmetic rules in solving algebraic problems and equations? Can you substitute the given value in the corresponding equation or expression? Do you have concept of generalization of arithmetic rules in algebra? Do you know any idea in know quantity and unknown quantity? ", The responses from the students were as below:

"I don't know the clear concept of transition from arithmetic to algebra. I have a lot of confusion regarding these problems. I have few ideas to know about known and unknown quantity but I don't have proper knowledge to generalize them. In solving equation like, 5x + y = 10 where x = 2 and y = 3, I get confused to solve this problem and do not get solution. So I guess and just get answer on my guessing capacity."(Grade 7 student view)

"As far I know, the transition from arithmetic to algebra collects the various problems including variables, equation, expression and word problems, so these complex set of inclusions make me hard to understand it and solve mathematically. I am always confused to translate the arithmetic concept to be generalized in the algebra and feel more difficult to understand like, If the length and breadth of a rectangle are 7m and 5m respectively, I am able to calculate the problem to find the Area and Perimeter. But if the length of rectangle is (3x + 2y) m and its breadth is (2x - 3y + 2) m, then I am confused and unable to calculate its Area and Perimeter

properly. Moreover if the values of 'x' and 'y' are given, I feel doubt to use this value when needed to and face problem to simplify." (Grade 8 student view)

The above study shows that transition from arithmetic to algebraic problem is difficult for students. As per above response analysis, there we can see very less percent of the total students have been able to provide the correct answer and more of the students are not able to give right answer of the problem. This is because we can say that the students didn't get proper idea to solve the problem where they faced generalization, translation, substitution problem as well as language verbal problem to understand and formulate it correctly. In expression and equation they were unable to substitute the values properly and they just expressed the answer on their guessing concept. In algebraic problems, students start from unknown quantities (variables), identify relationship between variables to formulate an equation and then solve that equation to find a solution to the problem. When students interpret equality as a direction to calculate, they often use arithmetic method. Therefore, students do not appreciate the utility of algebraic method and students ignore variables and signs. This above problems were related to the language based learning disability and mathematical learning disability because these ability associates the skills such as speaking, reading, reasoning, manipulation of algebraic problem with appropriate rules, procedures and mathematical calculation.

Chapter V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMENDATION

The data collected during this study have provided valuable information about students' knowledge, experiences and understandings with algebra in grade 6, grade 7 and grade 8. The study participants offered great feel into the difficulties with algebra that are faced by students. The objective of this study was to explore students' difficulties in five main conceptual areas of algebra and, expose student view and experience on it. By doing this, researcher assumed that the difficulty is directly related to students' mathematical thinking, understanding and their actions. After the analysis and interpretation of the collected data, according to the design and conceptual areas this concluding chapter obtained. This chapter contains the area as summary, findings, conclusion and recommendation for further study.

SUMMARY

Algebra is related to arithmetic and geometry because the problems of algebra can be considered in the figure of geometry and any particular form of arithmetic can be considered in the general form of algebra and therefore algebra is very important for us in daily life as well as further study of Mathematics and other subjects. Most of the students can not solve the problem of algebra due to the different difficulty but some students have succeeded in it without well understanding of algebraic relations. This was a small scale study of concurrent mixed method with quan- qual form related to students' difficulties in learning algebra at grade 6, 7 and 8. The objectives of study were to find out the students difficulties in learning algebra at lower secondary level.

For this study the researcher selected two government schools of Nuwakot district. The researcher selected 150 students in which 47 students were class 6, 53 students were class 7 and 50 students were class 8. The researcher had constructed the questionnaire for achievement test on the basis of students' difficulties in learning algebra. Achievement test and interview were conducted at Shree Sundarikeurini Secondary school and Shree Prithvi secondary School, Nuwakot. The researcher calculated the mean and percentage within the given difficulties area in which class-wise incorrect and correct response percentage and overall response percentage were also calculated. The researcher selected ten students for interview from each difficulties area whose responses were totally incorrect.

Most of the students have faced difficulties in learning algebra due to their learning disability which is created by the lack of understanding of algebraic relations and procedures. Students have bad feelings and understanding about mathematics especially in algebra. Many students were responded to incorrect answer in achievement test and only few students responded to all correct answer. They have lack of understanding of variable, managing of variable, misuse of rules and procedures, oversimplification, guessing reasoning and problem in generalization of arithmetic rule in algebraic form properly are the major obstacles in learning algebra. The causes of difficulties were increasing the misunderstanding of algebraic concept, relation and procedure and thus students felt this topic is more difficult to understand.

Findings of the Study

On the basis of analysis and interpretation of the result, the findings of the study were as follows:

- The study shows that comprehending variable was the most difficult area for students in which 22% responded to all incorrect answer and only 7.33% responded to all correct answer in overall and others responded either one or two correct answer. In which lack of understanding of variable was major problem in comprehending variables.

- The study shows that second difficult area was word problem because 16% students responded to all incorrect answer, and only 8% responded correct answer and others responded one or more than one correct answer in overall. Language and vocabulary, understanding of the word problem, translating in mathematical form and simplification were main difficulties in word problem.

- The study shows that solving equation was third difficulty for students. In overall 13.33% responded to all incorrect answer, 14% responded to correct answer others responded one correct or two correct or three correct answer. Misunderstanding of equation solving methods, rules and procedures, guessing reasoning, incomplete and oversimplification were the most familiar difficulties in solving equation.

- The study shows that algebraic expression was fourth difficulty because only 12.67% students responded to all correct answer, 10.66% responded to all incorrect answer and others responded to one or more than one correct answer. Understanding the expression, simplify the expression with appropriate mathematical operation and incomplete simplification were main difficulties in dealing with algebraic expressions.

- The study shows that fifth difficulty was transition from arithmetic to algebra, in which the highest percentage of students (16.67%) responded to all correct answer, 10% responded to all incorrect answer and others responded to one more than one correct answer. Lack of knowledge about using arithmetic rules in algebra properly, problem in generalization of arithmetic rules in algebra, problem in moving from arithmetic to algebraic strategy for solving algebraic problem, problem in substitute the given value in the corresponding problem and transition from arithmetic thinking to algebraic thinking were main difficulties in transition from arithmetic to algebra.

- The class- wise response percentages also shows the difficulties occurred are alike accordingly.

- The actual mean of the achievement test was 8.96 only which is less then assumed mean 10 on the test, this shows that students have problems in the given difficulties areas and found high number of difficulty level.

CONCLUSIONS

On the basis of the finding of the study, there were many difficulties in learning algebra faced by students at lower secondary level. The major difficulties were comprehending variables, algebraic expressions, solving equation, word problems and transition from arithmetic to algebra. These difficulties were developed students misunderstanding of variable, bad algebraic thinking and misuse of algebraic relations as well as procedure about algebra. One major component of developing difficulties in algebra was misunderstanding of variable, whose impacts were founded

in all algebraic activities. And other problems were misuse of signs and symbols, language and vocabulary, understanding of equation solving methods and rules, understanding and translating of word problems, and transition from arithmetic thinking to algebraic thinking properly. Also the result of the study indicates that students' problems were incomplete solution, oversimplification, lack of algebraic language and vocabulary, guessing reasoning and incorrect generalization of arithmetic rules in algebra. In this study, it is concluded that difficulties in learning algebra plays the vital role to obtain the low achievement in algebra.

RECOMMENDATIONS

On the basis of findings and conclusions the following recommendations are suggested as: Another study needs a proper identification and a micro analysis of difficulties, study needs using technology to explain algebraic concept and difficulties, study needs linking between arithmetic and geometry for teaching / learning algebra and studies need at all level of school mathematics etc. The teacher should understand the students' difficulties in algebra and these difficulties may be addressed with applying proper procedures and student centered strategy for teaching. Teacher should encourage the students and to motivate for regular study. Teacher should be able to link algebra to other mathematical concepts and real life context makes algebra meaningful and interesting for students. Students should gain the difficulties in algebra and thus may be solved problems carefully as well as minimize their difficulties by the help of teacher. Administrators and curriculum planners should obtain the difficulties in learning algebra and manage these problems with proper manner. This study was conducted within only two government schools of Nuwakot district with small sample. Hence the results of this study cannot be generalized for other schools.

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Appendix-A

Achievement Test in Algebra at Lower Secondary

1. A letter that represents more than one number or value is called ……………

      a. variable   b. constant   c. number   d. term

2. Ram has x copies and y books, then x and y are …………………………

      a. coefficient   b. constant   c. variables   d. term

3. Hari has y pencils and Shyam has three times as many pencils as Hari, then y is ………..

      a. number   b. variable   c. constant   d. none

4. What is the value of $x + 2x + 3x + 4x$?

      a. x   b. 9x   c. 8x   d. 10x

5. The expression $x + y$ is known as …………………

      a. monomial   b. binomial   c. trinomial   d. none

6. Which is greater, $y + 3$ or $y + 1$?

      a. $y + 3$ b. $y + 1$ c. equal   d. none

7. The expression $\frac{3x}{2} - \frac{x}{2}$ is equivalent to:

      a. x   b. 4x   c. 2   d. 1

8. What does yz means?

      a. y multiplied by z   b. constant   c. both   d. none

9. What is the value of y in the equation $y + 8 = 10$?

      a. 10   b. 8   c. 18   d. 2

10. What is the value of p if $p = q + r$ and $p + q + r = 20$?

      a. 5   b. 10   c. 20   d. 15

11. In the equation $2x = 10$, the constant value of x is …………………..

      a. 5   b. 2   c. 10   d. 8

12. What is the value of x and y in the equations x - y = 6, and x + y = 4?

      a. 6,4   b. 2,8   c. 5,-1   d. 4,-2

13. If 3 is added to x and the result is 9 what is the expression?

      a. 3x + 9   b. x + 3 = 9   c. x + 3   d. 9

14. If 9 is added to the product of 3 times of a number, then the expression becomes

      a. 3x = 9   b. 3x - 9   c. 3x + 9   d. 3x

15. Ram is p years old now. How old will he become after 5 years?

      a. p   b. 5p   c. p + 5   d. 5

16. Gita has x apples. She gave 2 apples to her friend and got 5 apples from her father. How many apples are with Gita now?

      a. x - 2   b. x + 3   c. x + 7   d. x + 5

17. What is the value of x + 5 when x = 2?

      a. 8   b. 5   c. 7   d. 10

18. What is the value of 2a + 3b when a = 2 and b = 4?

      a. 5   b. 7   c. 14   d. 16

19. The sides of a triangle are x, 2x and 3x respectively. What is the perimeter of a triangle when x = 3m (m = meter)?

      a. 6m   b. 18m   c. 20m   d. 16m

20. What is the area of rectangle if its length and breadth are y and 2y respectively when y = 4m?

      a. $8m^2$ b. $16m^2$ c. $32m^2$ d. $12m^2$

Appendix-B:

Composition of questions in different categories in the test:

Category/ Area	Item numbers
Comprehending variables	1, 2, 3
Algebraic expression	4, 5, 6, 7, 8
Solving equations	9, 10, 11, 12
Word problems	13, 14, 15, 16
Transition from arithmetic to algebra	17, 18, 19, 20

Appendix-C:

Incorrect and Correct response percentages for grade 6, 7 and 8:

	Incorrect Response Percentage			Correct Response Percentage		
	Grade 6	Grade 7	Grade 8	Grade 6	Grade 7	Grade 8
Comprehending variable	21.28%	22.64%	22%	4.25%	9.43%	8%
Algebraic expression	10.6%	7.5%	14%	8.51%	13.2%	16%
Solving equations	19%	11.3%	10%	10.6%	11.32%	20%
Word problems	23.4%	13%	12%	6.38%	9.43%	8%
Transition from arithmetic to algebra	8.51%	11.32%	10%	14.89%	15.09%	20%

Appendix-D:

Overall/Detailed response percentages of each category as a whole:

	incorrect response	Correct response	1 correct response	2 correct response	3 correct response	4 correct response
Comprehending variable	22%	7.33%	54.6%	16%	-	-
Algebraic expression	10.66%	12.67%	31.33%	17.33%	16%	12%
Solving equations	13.33%	14%	30.67%	32%	10%	-
Word problems	16%	8%	26.67%	33.33%	20%	-
Transition from arithmetic to algebra	10%	16.67%	31.33%	19.33%	22.67%	-

Appendix-E:

Statistical formulae used in the analysis:

1. Mean($\overline{X}$) = $\frac{\sum fx}{N}$

2. Correct response Percentage = $\frac{No.of\ correct\ respondent}{total\ no.\ of\ respondent} \times 100\ \%$

3. Incorrect response Percentage = $\frac{No.of\ incorrect\ respondent}{total\ no.\ of\ respondent} \times 100\ \%$

Appendix- F

Interview Guidelines for the Students

The interview had been taken under the basis of following areas:

    a. Difficulties in comprehending variables:

- Meaning of variable and constant
- Examples of variables
- Different between variable and constant
- What are the causes of difficulties in comprehending variables?

    b. Difficulties in dealing with algebraic expressions:

- Meaning of algebraic expression
- Addition, subtraction, multiplication and division of algebraic expression
- Closure, associative and distributive property of algebraic expression
- Types of expression like as monomial, binomial etc

    c. Difficulties in solving equation:

- Meaning of equation
- Meaning of linear equation
- Solving methods of equation
- Examples of equation
- Simplification of equation

    d. Difficulties in word problem:

- Examples of mathematical word problems
- Translate mathematical word problem into appropriate algebraic expression
- Difficulties of vocabulary concerning with mathematics
- Inconsistent in use of appropriate sign and symbols

    e. Difficulties in transition from arithmetic to algebra:

- To use arithmetic rules in solving algebraic problems
- Moving from arithmetic to algebraic strategies for solving equation
- Substitute the given value in the corresponding statement or expression
- Knowledge about using arithmetic rules properly
- Ability of generalization of arithmetic rules in algebra