STUDENTS' DIFFICULTIES IN SOLVING ALGEBRAIC WORD PROBLEM AT SECONDARY LEVEL

A

THESIS

BY

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FOR THE PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF EDUCATION

SUBMITTED

TO

DEPARTMENT OF MATHEMATICS EDUCATION

CENTRAL DEPARTMENT OF EDUCATION

UNIVESITY CAMPUS, KIRTIPUR

TRIBHUVAN UNIVERSITY

KATHMANDU, NEPAL

2019

त्रिभुवन विश्वविद्यालय

शिक्षा शास्त्र केन्द्रिय विभाग

गणित शिक्षा विभाग

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Letter of Certificate

This is to certify that **Mr. Pashupati Nath Das,** a student of academic year 2072/073 with campus Roll Number 475. Thesis Number 1397, Exam Roll Number 7228342 and TU Registration Number 9-2-834-250-2012 has completed this thesis under supervision of Mr. Abatar Subedi for the period prescribed by the rules and regulations of Tribhuvan University, Kirtipur, Kathmandu, Nepal. This thesis entitled **"Students Difficulties in Solving Algebraic Word Problem at Secondary Level"** has been prepared based on the result of investigation conducted during the period of August 2018 to April 2019 under the Department of Mathematics Education, Tribhuvan University, Kathmandu. I hereby recommend and forward that his thesis be submitted for the evaluation as the partial requirements to award the Degree of Master of Education.

….……………………………………

(Assoc. Prof. Laxmi Narayan Yadav)

Head

Date: May 2, 2019

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Letter of Approval

This thesis entitled **"Students Difficulties in Solving Algebraic Word Problem at   Secondary Level"** submitted by **Mr. Pashupati Nath Das** in partial fulfilment of the requirement for the Degree of Master of Education has been approved.

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Recommendation for Acceptance

This is to certify that **Mr. Pashupati Nath Das,** has completed his thesis

entitled **"Students Difficulties in Solving Algebraic Word Problem at**

Secondary Level" under my supervision during the period prescribe by the rules

and regulation of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend

and forward his thesis be submitted to the Department of Mathematics Education to

organize final viva-voce.

…………………………

(Abatar Subedi)

Supervisor

Date: May 2, 2019

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Dedication

This work is affectionately dedicated to my father Mr. Raj Kumar Das and mother Mrs. Jibchhi Devi Das who even in a very difficult situation gave me a great span of their life for what I am now.

Declaration

I hereby declare that this thesis is my original work. It contains no material which has been accepted for the award of other degree in any institutions. To the best of my knowledge and belief that this thesis contains no material previously published by any authors except due acknowledgement has been made.

………………………..

(Pashupati Nath Das)

Date: May 26, 2019

Acknowledgements

I am greatly indebted to my supervisor Mr. Abatar Subedi, Department of Mathematics Education, T.U. Kirtipur for his proper guidance, suggestion, encouragement and supervision. Without his guidance this would not be successful. Through, I haven't found any such word to express my deep gratitude to him for his kind help.

I would like to express my sincere gratitude to my respected teachers, Assoc. Prof. Laxmi Narayan Yadav, Head of Department of Mathematics Education and Mr. Krishna Prasad Adhikari for their valuable comments and suggestion. I wish to express my grateful appreciation and indebtedness head teacher, mathematics teacher, mathematics exports and students of concerned school for their kind co-operation and providing opportunity for collection of data.

Finally, I am very grateful to my parents. Mr. Raj Kumar Das and Mrs. Jibachhi Devi Das for essential spirit, inspiration, encouragement and support in my study. I also grateful my friend Mrs. Renu Sah and brothers Mr. Bhola Das and Mr. Mahadev Das for their valuable help and co-operation in my research study.

………………………

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Date: May 26, 2019

Abstract

This is a small-scale survey research related to "Students Difficulties in Solving Algebraic Word Problem at Secondary Level". This research was conducted to identify students' difficulties and to find the ways of minimizing students' difficulties in solving algebraic word problem at secondary level. For, 105 students, two mathematics teachers and three math experts were selected by using convenience sampling method. Also, 10 students selected for the purpose of interview. The data was collected from achievement test and interview schedule. The collect data were analyzed and interpreted with using percentage for quantitative data and general inductive method for qualitative data.

The finding of this study shows that students have faced difficulties in language, comprehension, conceptual, transformation, formula selection, equation solving, transition from arithmetic to algebra and solving process while they solve algebraic word problem because students unable to understand the mathematical concept, fact, word meaning formulas pattern. Similarly, students have poor vocabulary, lack of pre-knowledge, less practice in word problem, unable to choose appropriate method, make mistake in calculation etc. So, it can be minimized if teacher should clear the concept to the students by use concrete materials. He/she use pattern of formula while teaching and provide basic knowledge before starting the topic. Also, students focus on more practice, emphasis vocabulary word meaning, and teacher must be used technology to clear the concept.

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Chapter I

Introduction

Background of the Study

Mathematics is useful and necessary for day to day activities of human beings and is also important discipline in the world. There are different branches of mathematics. One of them is algebra. Mathematics is recognized as the "science of patterns" and pattern is the heart of algebra it shows that the crucial role of algebra in mathematics. Algebra deals with symbols and the rule for manipulating those symbols.

Algebra is one of the major content domains covered to promote the acquisition of mathematical knowledge and skills in school mathematics. Algebra is introduced at the junior high school level and continued through to senior high school and tertiary level. At the junior high school, algebra covers topics such as algebraic expressions, linear equations, relations, mapping and functions (Ministry of education, 2007). At the senior high school algebra is taught to all students as core mathematics (Ministry of education, 2010). According to the mathematics curriculum, the concepts of algebra are to help students establish the relationship between numbers and their usage in real life. In the domain of mathematics, algebra focuses on generalization and interpretation of patterns and relationships. The knowledge of algebra is so important that its utility is needed by everyone. Despite its importance not all students at the junior high school level can cope with formal algebra (Martin et al., 1994).

Students' primary difficulty in solving word problems is attributed to their " Suspension of sense-making" (Schoenfeld, 1991). Instead of thinking through the context of

the word problem to understand it, many students simply seek a simple application of arithmetic needed to produce an answer, whether it makes sense or not. Students can also struggle with word problems because they have difficulty with academic vocabulary, mathematical vocabulary, or both. Due to these difficulties, English language learners and students of low socioeconomic status score lower on standardized assessment items than proficient speakers of English (Abedi & Lord, 2001).

Learning difficulties of algebra for students may directly be related to teacher's mathematical knowledge, use of materials, classroom practices, pre- knowledge of student, learning environment, lack of understanding basic concept of the variables in different context, transition from arithmetic to algebra, unable to understand about the mathematical terminology and poor vocabulary and so on. This study focuses on students' difficulties in solving algebraic word problems of secondary level. Egodawatte (2011) carried out the students' difficulties comes from misunderstanding and misconception of variables, operation, symbols, expressions, notation etc. This different types of misconception and misunderstanding students get difficulties solving algebraic word problems.

From the above discussion, it seems that more students have been facing number of difficulties in solving algebraic word problems at secondary level. So, I tried to find out the students' difficulties in solving word problems at secondary level with the purpose of explaining some causes of difficulties in solving words problems in algebra at secondary level.

Statement of the Problem

According to SEE result, 2074 most of the students obtain low grade (fail) in mathematics. It is one of the important sociological issue of mathematics education in our Nepalese context. Higher failure rate in mathematics at secondary level is due to triangular gap between students' potentiality, mathematical content, mathematics instructor (Shrestha, 2017). It means teacher focus on rote learning in the class, doesn't use materials and use only teacher centered method. So, the mathematical educators are also responsible for these phenomena. Also, Egodawatte (2011) and Wright (2001) argue that the reason of low achievement in mathematics is due to misunderstanding and misconception of algebraic knowledge, symbols, expression and more formula are used in algebra which is difficult to remember for students, students unable to represent algebraic word problems into mathematical (symbolic) form.

When I was teaching at Shree Santiniketan Secondary School Rajbiraj, Saptary, I had faced some difficulties in teaching algebra at secondary school. Most of the secondary students feel difficult in solving algebraic word problems and makes more errors other than non-algebraic word problem. Therefore, researcher selected this research problem "Students Difficulties in Solving algebraic Word Problems at secondary Level." So that this study based on the following research questions:

- What are students' difficulties in solving algebraic word problems at secondary level ?
- How can the teacher minimize the students' difficulties in solving algebraic word problems at secondary level ?

Objective of the Study

The objectives of this study were:

- To identify the students' difficulties in solving algebraic word problems at secondary level
- To find the ways of minimizing the students' difficulties in solving algebraic word problems at secondary level

Significance of the Study

Many researchers show that many students take algebra as difficult topic than other branches of mathematics. So, students take algebraic word problem is more difficult other than non-algebraic word problem. Students unable to express algebraic word problem into mathematical forms. Students cannot understand mathematical terminology, variables, expression etc. Thus, we focus in this study to identify and ways minimizing the students' difficulties in solving algebraic word problems. The main significance of this study are as follows:

- The results of this study would helpful for students, teacher, curriculum maker and education administrators to use appropriate method, construct curriculum and manage classroom environment based on difficulties respectively.
- It helps to students and teacher for algebraic teaching and learning.
- It helps teacher to minimize students' difficulties and clear the concept, use suitable method and visualized the problem by using concrete materials.
- Its finding would help to reduce the difficulties in word problem and improve the mathematics achievement.

Delimitation of the Study

Delimitation of the study determines the boundary of the study area. This study also has some delimitation, which are follows

- This study was based on secondary level students in solving algebraic words problem of Kathmandu district.

- This study was carried only a problem of difficulties in solving word problem at secondary level.

- This study was completed based on interview guidelines and achievement test.

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

Operational Definition of Related Term

Here, for these some more significant terms are given. Those given word terms reflect the whole thesis and gives particular meaning aspects. These terms, to make easy understanding of the problem and ambiguous meaning of terms should be defined clearly which can be otherwise interpreted in different ways.

Problem solving. In this study problem solving means students' skill in the use of symbols, property, relations and understanding knowledge of word problem.

Difficulties. In this study difficulties refers to reading and language difficulties, comprehension difficulties, conceptual difficulties, difficulties in formula selection, equation solving difficulties, solving process difficulties, transformation difficulties and transition difficulties.

Algebraic expression. In this study an algebraic expression is a mathematical phrase that can contain ordinary number, variables and operators.

Variables. In this study variables refer to number or letter representing an unknown member of a set. In algebraic expression, a variable's stands for a value.

Misconception. In this study misconception refers to students' belief, view, or opinion, ideas that is incorrect with algebraic symbols, notations, terminology etc.

Symbols. In this study symbol refers specifically to mathematical symbols. It includes letter, number, equal sign, plus, minus, multiple, division sign, square root etc.

Chapter II

Review of Related Literature

The intension of the literature review is to determine what to be done in the concern area of the research topic. Review of literature help 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. So that researcher reviewed some literatures which are given below:

Empirical Literature

The empirical study of literature is an interdisciplinary field of research which includes the psychology, sociology, philosophy, the contextual study of literature and the history of reading literary texts (Khanal, 2017). So, researcher reviewed the following literatures:

Adhikari (2007) studied on "An error analysis in mensuration of grade IX students in Kathmandu district." The objectives of this study were to compare the error made by students in knowledge, skill and application & problems solving of mensuration, to compare the error with respect to gender, analyze the errors made by the students' problem solving. Samples of this study consisted of 80 out of 120 students were selected by lottery method. In this study mixed method research design used. The main finding of this study was: the number of non- observable error is greater than number of observable errors. Children's have committed more error in area of problem solving, students' have more errors in the area of knowledge than in the area of skill and application, students

have committed more errors in the area of knowledge than in the area of skill and application, no significant difference can be committed by students in the area of problem solving and knowledge. And researcher also found no significance difference between the errors committed by the students in the area of problem solving, skill and application, girl committed more errors than boys in the area of knowledge, the role of gender is less important to commit errors in the area of skill & application and problem solving.

Similarly, Sharma (2009) conducted on study "An error analysis in solving algebraic problems of grade five students." The objectives of this study were to identify the error 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. The samples in this study consisted of 30 students from Janata Primary School, Surkhet. In this study, researcher was used mixed method design. And achievement test and interview schedule were tools of this study. The major findings of this study were as 75% of error occurred at the comprehension and transmission stage, 12% errors occurred at the process skill stage, 5% errors occurred at encoding stage, 8% errors occurred at due to careless of students and 40%, 34%, and 26% errors on knowledge level, skill and application level and problems solving level.

By review of above literatures, it is concluded that students lacked many of the desired instances of symbol sense that making in mathematics in general. Students' have committed number of errors on solving verbal problems if simplification & equation of algebra and students' commit more errors in knowledge level while solving verbal problems in algebra.

Furthermore, Poudel (2014) studied on "difficulties in learning trigonometry." The objectives of this study were to find the cause of difficulties in learning trigonometry and to minimize the difficulties in learning trigonometry at secondary level. This study was used qualitative design and sample was selected from one private & one public school. Interview and classroom observation are used for data collection tools. The major finding are students made error in solving algebraic problem, 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 enough materials for learning trigonometry and lack of interactive classroom.

Also, Aryal (2017) studied on "Influence of Symbols on Basic Level Students in Solving Algebraic Problem." The objectives of this research were to explore the symbol sense of basic level students in algebra and to identify the students' error in an operating algebraic problem. This study was used mixed method research design. Assessment test and interview schedule were used as tools of the study. The major finding of this study that errors made with these types of symbols can be traced back to misconception in arithmetic. The equal sign has different meanings for students and is not often interpreted to match anticipation, students sometime created new ways of accomplishing their goals that did not follow mathematical rules and student made errors students often worked within one representation type without making connection to any other type. Students often struggle to understand how a symbol could be used to help make sense of symbolic representation of problem.

From these reviews of literatures, it is concluded that most of the students makes errors in the area of knowledge and skill levels. Students develop difficulties misunderstanding of variables, bad algebraic thinking and misuse of algebraic relation as well as procedure about algebra.

Likewise, Khanal (2018), studied on "Difficulties in Solving Word Problem in Algebra." The objective of this study was to explore the difficulties in solving word problem and to analyze the major cause of difficulties in word problem in learning algebra. This study used qualitative design particularly the case study design. Test & interview schedule were used as tools of the study. The researcher selected 20 students from government school for test and six students were selected for interview. The major finding of this study was students unable to understand algebraic word problem into mathematical form, students directly solve the problem without understanding the problem correctly, students could not understand the meaning of the problem, student unable to translate word problem into mathematical form correctly, students unable to correct mathematical operation due to inability to use the correct mathematical sign. The cause of solving difficulties is lack of pre-algebraic knowledge, lack of the understanding of mathematical terms, students always emphasis on product only rather than process and inability to identify target variables.

From the review of Khanal, he explored only the students' difficulties and cause of difficulties, but he did not find how to reduce or minimize these types of difficulties. He focused difficulties related to reading, conceptual, comprehension, transformation and process. But this study, researcher found the way of minimizing these types of

difficulties. Also, this study focused difficulties related to language, equation solving, formula selection and transition. And researcher used mixed design (embedded sequential design) where researcher worked in quantitative and less work in qualitative. So, this study is differed from Khanal. But researcher continued this study with help to Khanal.

Moreover, Kenney (2008) studied on "influence of symbols on pre-calculus students' problems solving goals & activities." The objectives of this study were to investigate students uses and interpretations of mathematical symbols and the influences that symbols have on students' goals and activities when solving tasks with & without a graphing calculator. 6 samples were selected from college students and qualitative (case study) design used. The finding of this study that symbols and symbolic structures had strong influences on students' choices in problem solving. Graphing calculators used as a way to abandon symbolic manipulation, although few connections were made between symbolic & graphic or numerical form.

Similarly, Egodawatte (2011) studied on "Secondary school students' misconception in algebra." In this study major research question were (i) what secondary school student's categories of errors and misconceptions in are solving problems related to variables and (ii) what are secondary school students' categories of error and misconception in solving word problem. Sample was selected from grade 11 students in an Urban Secondary school in Ontario and mixed method design was used. Interview and algebraic test were the main tools of this study. This study concluded that the difficulty of directly accessing students mathematical thinking and reasoning behind their action and misapply rules or procedure which are inappropriate in certain algebraic solution.

Moreover, Wright (2014) studied on "An Investigation of Factor Affecting student Performance in Algebraic Word problem solution." The specific research goals were to determine (i) a measure of correlation between students' performance in the ability to identify written clues indicative of mathematical operations and overall problem-solving performance on an AWP, (II) a measure of correlation between students' performance in the ability to recognize relation statements between component parts of written text and overall problem-solving performance on an AWP. Sample was included 163 students (92 females, 71 males') from nine classrooms. The blend of qualitative and quantitative data identified the study as a mixed methods model. The researcher addressed the potential differences between genders, ethnicity groups, grade levels, and course in the overall ability to correctly solve a selection of AWPs as measured by the variable CS, the mean score for four AWP solution effort.

Thus, from the review of Kenney, Egodawatte and Wright, it is concluded that students' difficulties come from poor basic knowledge, misapply rules or procedure which are inappropriate in certain algebraic solution.

Implication from the above Empirical Review

From the above review of literatures, it is concluded that students' faced difficulties in solving algebraic word problems by the students are particularly related to language aspects of algebra, confusion about terminology, mathematical ideas, fact skill and unable to make the plan. And students' have lack of understanding of the basic concept of the variables in different context, lack of pre-knowledge. Students unable to understand the pattern of the formula, poor vocabulary, unfamiliar words. Also, students

unable to generalized arithmetic rules in algebra. Thus, students easily solve the problem if above mentioned aspects are addressed.

Review of Theoretical Literature

Theoretical literature review describes learning theories in mathematics. It supports to construct the framework to achieve the objectives of the study. There are different kinds of theories. They are behaviorist theory, cognitive theory, social constructivist theory, structural functional theory, cultural theory, learning disability theory, & constructive theory and so on. Among them I will use constructivist learning theory and learning disability theory and discuss below:

Constructivist learning theory. The study is based on the social constructivist theory of learning. According to the constructivist knowledge is always as the result of constructive activity. It must be actively constructed by individual learner. This can only happen by relating the unknown to what is already known. The learning of mathematics is a constructive process. (Mary, 2016). Piaget (1970) researched on this idea and pointed out the new objects and events should be related intellectually to those of earlier experience. By this theory, students do not just passively receive in formation but constantly create new knowledge based on prior knowledge in conjunction with new experience. Marrian and Ceffarella (1999) "meaning of an event is dependent upon the individuals previous and current knowledge structure. "Therefore, to make sense of a new materials the individuals will have to use the existing knowledge. They will have to use their knowledge of number and arithmetic as the students learn algebra according to Simon, et.al, (2000), radical constructivism operates under the following assumption; (a)

human only have access to mathematics that is created through their own activity and is dependent on their own activity and is dependent on their way of knowing,(b) learning is a process of trans formation or modification of existing ideas. (c) individual can only see, understand, and learn new concept based on what they already know.

According to constructivism "Students need to construct their own understanding of each mathematical concept." So that primary role of teaching is not to lecture, explain or otherwise attempt to 'transfer' mathematical knowledge but to create situations for students that will foster their making the necessary mental construction. Constructivist approach focuses on the key ideas of the relationship of among ideas within the subject areas and across subject areas. Applying this, teacher emphasize on the connections of important concepts that are the major ideas for the discipline rather than isolated bits of knowledge.

In constructivism theory, students need to construct their own understanding of each mathematical concept and how they can learn. Thus, the teacher must encourage students to use active techniques to create more practical knowledge.

Constructivist principles support under achieving students in their study of mathematics by embedding important skill learning in meaning full (Khanal, 2018). Students with learning difficulties should not be excluded from the opportunity to develop mathematical skill and the opportunity to gain conceptual knowledge to solve problems. So, students with learning difficulties often demonstrate conceptual performance that exceeds what would be predicted based on their current performance level (Goldman & Hasselbring,1997). In algebra word problems, may teacher

consistently use concrete materials to introduce many ideas then students get the abstract, symbolic, and boring in algebra word problems. In constructivism approach, teacher to promote and support the invention approach students learning process and guide to focus in students learning activities.

Problem-Solving: G. Polya's Approach. Problem solving is an appropriate and important activity in school mathematics because the learning objectives that are meet by solving problem and learning general problem (Bell, 1979). Finding the answer is not the answer. Most students just want to find the answer, never mind how. Also, problem solving requires practical knowledge mistakes or incorrect assumptions (Polya, 1957). Problem solving is the basic mathematical activity. The mathematical activities such as generalization, abstraction, theory building and concept formation are based on problem solving (Acharya, 2017).

George Polya's discusses the four steps of problem solving these are: (a) understand the problem: obviously if students don't understand a problem, they won't be able to solve it. So, it is important to understand what the problem asking. This requires that they read slowly the problem and carefully understand the information given in the problem, (b) division a plan: in devising a plan, think about what information you know, what information you are looking for, and how to relate these pieces of information, (c) carry out the plan: persist with plan that you have chosen. If it continues not to work discard it and choose another, (d) look back: this step helps in identifying mistake, if any. Check see if your answer is plausible. Looking back also gives you an opportunity to make connections. Schoenfeld (1991) devised a model for analyzing problem solving that was

derived from Polya's model. This model describes mathematical problem solving in five levels: reading, analysis, exploration, planning and verification. Schoenfeld discovered that expert mathematicians returned several times to different heuristics episodes. If students mention above four steps, then they easily solve the problems.

Theory of disability. Learning disability or learning disorder is a condition in the brain that causes difficulty and struggle to comprehend or process in formations and can be caused by several different factors. "Learning disability "generally refers to and intellectual disability. (Anderson & Meier, 2001).

Mathematic learning disability not often occurs the clarity and simplicity. Rather they can be combination of difficulties which may include language processing problems, visual spatial confusion, memory and sequence difficulties and unusually high anxiety (Dhital, 2016). Learning disabilities are disorders that affect one's ability to understand or use spoken or written language, do mathematical calculation, coordinate movements, or direct attention (Psychologytoday.com). Learning disability is general term that describes specific kinds of learning problems. A learning can cause a person to have trouble learning and using certain skills. The skills most often affected are reading, writing, listing, speaking, reasoning and doing mathematics (Limbu, 2018). The students' difficulties in word problems comes from misconception. Avoiding any misconception of being disable with a lack of ability to learn and possible negative stereotyping. While learning disability, learning disorder and difficulty are often used interchangeably.

Finally, learning disability is a burning problem of modern area, one in secondary school mathematics students is likely to suffer this condition. Teacher and parents are

becoming more and more aware of the condition. And, shows sensitivity to the reality of learning disability and has created certain provision in the policy and practice to help students with learning disabilities (Khanal,2018). With the awareness that math understanding is actively constructed by each learner, we can intervene in this process or advocate for provide experience with manipulative, time for accurate language, access to helpful technologies, understanding and support.

Conceptual Framework

Conceptual framework refers to the mental picture of the things in consideration. When we think of something an image is created in our mind. This type of mental structure is known as conceptual framework. Conceptual framework of the study deals about the concept of possible area of the study. In this study researcher tried to find the students difficulties in solving algebraic word problem at secondary level. The objective of this study was to identify students' difficulties & to find the way of minimizing students' difficulties in solving algebraic word problem at secondary level. On the basic of above empirical and theoretical literature review, problems on difficulties in solving algebraic word problem such as: lack of teaching translation into mathematical symbol, language difficulties in word problem, difficulties in transition from arithmetic to algebra, difficulties in process involve the reading compression and how students make a plan to solve (Khanal, 2018). These types of difficulties, researcher was understood in this problem. By above review, constructivist learning theory, Polya's problem solving theory and theory of disability were helped to expose these types of difficulties in solving algebraic word problems. Now, researcher shown these difficulties in figure as below:

Title: the figure of conceptual framework of this study
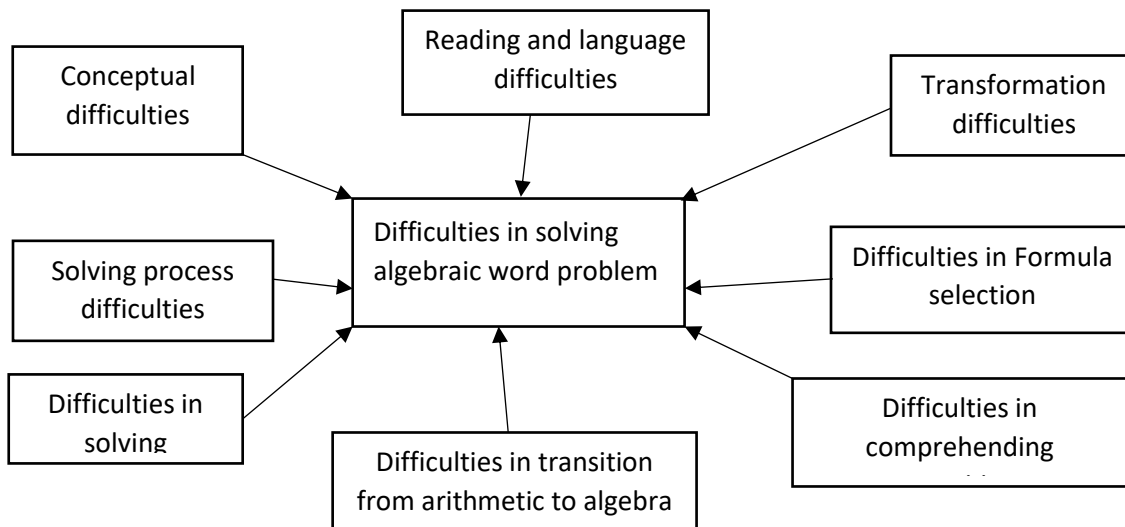
Source: Khanal, (2018)

The above figure shows that the students' difficulties in solving algebraic word problem which is explain below:

Conceptual difficulties. Conceptual understanding is good knowledge for solving problem in mathematics. It helps to making connection among ideas, fact, skill and reflection refining one's own understanding. In algebra, when students solve algebraic word problem then students first understand the word problem after we make a plane what to known or unknown?, what to find? etc. These types of knowledge as like conceptual understanding. Thus, conceptual knowledge is required knowledge for solving algebraic word problem. Otherwise it is difficult to solve.

Reading and language difficulties. Reading and language skill are vital role for solving algebraic word problem. If students able to read mathematical word problem clearly and understand this language, symbol, picture then students understand

mathematical ideas by making connection between language, symbols and easily solve otherwise difficult to solve algebraic word problem.

Difficulties in comprehending variables in algebra. Letters represent different meaning in different context. When letters are present in algebraic entities, this is a seeming difficulty for students. For example, in arithmetic, 8m can mean 8 meters that is, 8 times 1 meter. But in algebra, 8m can mean 8 times some unknown number of meters.

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 to thinking to algebraic thinking. Thus, students can not clear about an arithmetic strategy to solve algebraic word problem.

Difficulties in formula selection. A formula is a special type of equation that shows the relationship between different variables. It is used to solve a problem, or a way to make something. Proper formula selection leads the student to write an equation, based on the formula structure in which specific values within the algebraic word problem replace variables within the formula. The formula is a pattern used to symbolically state the relationship expressed in the algebraic word problem. Most of the students are unable to select appropriate formula. So, students make difficulties in solving algebraic word problem.

Transformation difficulties. Transformation is importance role in solving algebraic word problem. If students can translate word problem into mathematical form and select appropriate mathematical operation, then it is considered as no transformation difficulties and students easily solve problem otherwise difficult.

Difficulties in solving equation. An equation is a statement of an equality containing one or more variables. In algebra when two algebraic expression combine with equal sign (=) is called equation. To solve equation one most known difficulties was the application of rules of simplifying equation based on given question.

Solving process difficulties. Solving process is requirement knowledge for students in solving problem. If students able to correct mathematical operation, calculation then students easily to solve algebraic word problem otherwise difficult to so

Chapter III

Methods and Procedures

This chapter deals with the plans and procedure of the study, which was carryout to achieve the objective of this study and to get the answer of the statement of the problem. This chapter includes design of the study, tool, data collection procedure and data analysis procedure.

Design of the Study

The purpose of this study was to identify difficulties and to find the way of minimizing students' difficulties in solving algebraic word problem at secondary school. So, researcher used mixed method particularly embedded design. According to Creswell (2008), the embedded design is a mixed method design in which one data set provides a supportive, secondary role in a study primarily on the other data types. And it concludes the collection of both quantitative and qualitative data, but one of the data types plays a supplemental role within the overall design. This design used qualitative result to assist in explaining and interpreting the finding of quantitative study. So, researcher used a test instrument for quantitative data and interview for qualitative data.

Selection of School

There were three types of schools in Kathmandu district such as Government, Private and Community based schools. So, researcher selected two schools in Kathmandu district. One is community school (Mangal Higher Secondary School Kirtipur) and other is private school (Hill Town B. School Kirtipur) by using convenience sampling method.

Sample of the Study

For achievement test, researcher selected 105 students of grade IX of Mangal H.S.S. and Hill Town school, Kirtipur. Similarly, for interview, researcher selected ten students from grade IX having low performance according to achievement test result and selected related math teacher for interview. Also, researcher selected three experts of mathematics to find the possible solution to minimize the students' difficulties.

Tools of the Study

Since researcher used mixed method design with quantitative and qualitative approach. In this study the tools as achievement test and interview for quantitative and qualitative data respectively. Which explain as bellow:

Achievement test. Achievement test is a kind of assessment which is given to the students. It is widely used to evaluate the students formally. It helps to examine the knowledge of students on the particular subject matter.

By the help of achievement test, researcher identified the student difficulties in solving algebraic word problem. The test was consisted only subjective question. There were 16 subjective questions. Thus, the achievement test, full mark was 40 and pass mark was 16. Also, time duration was one hour thirty minutes. All the question was selected from algebra at grade IX mathematics text book and was in the form of word problem

Interview guidelines. In this research, the researcher used interview guidelines with respondent based on occurred students' difficulties. The researcher took interview to find out the objective of this study. The interview was designed on the basis of difficulties in comprehending variable, difficulties in reading & language, difficulties in

transformation, difficulties in process skill etc. The interview was taken ten students were chosen from low performance. Also, interview was taken two related mathematics teachers in the topic of teaching methods, relationship between students and participation of students in class, students' pre-knowledge in algebra and practice of algebra at home.

Also, researcher took interview with three mathematics experts by using interview guidelines for possible way of minimizes these types of difficulties. Information from students, teachers and experts which helped researcher to make conclusion. The interview guidelines for students are given Appendix-B, interview guidelines for teachers are given Appendix-C and interview guideline for experts are given Appendix-D.

Reliability and Validity of the Tools

Reliability is the degree of consistency of measure and validity refers to how well a test measures what it is purported to measure. So, the researcher used split half method to determine the reliability of achievement test and found reliability coefficient is 0.75 (Appendix-E). For the validity of tool questions organized simple to complex form and consulted with subject expert, mathematics teacher and thesis supervisor to judge the validation and their suggestion became incorporate.

Data Collection Procedure

Data collection is the process of gathering and measuring information on targeted variables in an established system, which enables one to answer relevant question and evaluate outcome (Khanal, 2017).

In this study the researcher visited the selected school with above tools and got permission from the school to consult the students the students' difficulties in solving

algebraic word problem. So, the researcher went to Mangal H.S.S. Kirtipur and met with principal of that school and asked for permission to conduct exam. The researcher conducted exam with the permission of principal where 70 students were presented out of 78 students of class nine.

Similarly, researcher visited Hill Town B.S.S. Kirtipur to get permission for administrate written test. The researcher got permission to take exam. In the same day, researcher took exam for 35 students out of 40 students. After finished the test, researcher met with mathematics teachers and said for interview and got time for interview.

After, achievement test the researcher checked copy and recorded the students' difficulties in solving algebraic word problem. And, based of result researcher discriminated students and researcher selected ten students having low performance for interview and selected two related mathematics teachers. The researcher constructed open ended guideline according to students' checked copy. Researcher took interview about 10 – 15 minutes each of the students. After that researcher took interview of related mathematics teacher about 20 – 30 minutes for each teacher helped of guideline. Teacher interview was related to students' participation, class work etc.

Then the researcher found out language difficulties, comprehension difficulties, conceptual difficulties, transformation difficulties, equation solving difficulties, formula selection difficulties, transition difficulties and solving process difficulties after analyzing and interpreting students' interview and teachers' interview. The researcher again constructed open ended type guideline according to these difficulties for the purpose of how to minimize these difficulties. The researcher met three mathematics experts, got permission and asked question based on that guidelines. The researcher got purposeful

data from experts by asking deeply from the experts' answers. In this way, researcher got data from the interview of experts and interview was conducted about 25 – 35 minutes from each of the expert. And at last researcher thanked them.

Data Analysis and Interpretation Process

In this research the researcher took achievement test and obtained quantitative data. Researcher analyzed this data by using simple statistical tools percentage. Similarly, researcher took interview and data collected in verbally form. The method of data analysis was general inductive approach. A general inductive approach for qualitative data analysis is described and details provided about the assumptions and procedures used. Also, the inductive approach is a systematic procedure for analyzing qualitative data where the analysis is guided by objectives and that can produce reliable and valid findings (Thomas 2006). So, the researcher analyzed of this data by transcribing, coding and developed the theme based on research objectives. The data was analyzed and interpreted under these themes and constant comparison method was used. Triangulation was used for the validity of the data.

Chapter IV

Analysis of Data and Interpretation of Results

This is a survey research related to students' difficulties in solving algebraic word problem at secondary level by applying mixed methods. The objectives of this study were to identify and to find the way of minimizing students' difficulties in solving algebraic word problem at secondary level. For this study, researcher selected two schools from Kathmandu district. An achievement test and interview schedule were used as data collection tools. Achievement test was conducted for 105 students of grade nine. Based on test result given in appendix- F, the researcher selected ten students who has obtained low achievement given in appendix-E for interview. Similarly, researcher selected two related mathematics teacher and three mathematics experts for interview. Obtained data from achievement test was analyzed using simple statistical tools percentage and obtained data from interview were analyzed and interpreted by using general inductive approach. Thus, the obtained data were analyzed and interpreted under the several headings as listed below:

- Reading and language difficulties

- Difficulties in comprehension

- Difficulties in formula selection

- Conceptual difficulties

- Solving process difficulties

- Transformation difficulties

- Difficulties in solving equation

- Difficulties in transition from arithmetic to algebra

The data related to each heading as listed above are analyzed separately in the following paragraphs.

Reading and Language Difficulties

Difficulties in Reading and Language means students unable to read mathematical word problem clearly and not understand this language, symbols, picture and terminology. If the students did not recognize key word or symbols which is used in the question, then they are unable to solve word problem.

Language refers to the ability of word meaning, vocabulary, terminology which are used in problem. So, researcher constructed question for written test in order to find out the students' difficulties in Reading and Language. When researcher checked exam paper the researcher found more students are unable to understand word vocabulary in the two questions.

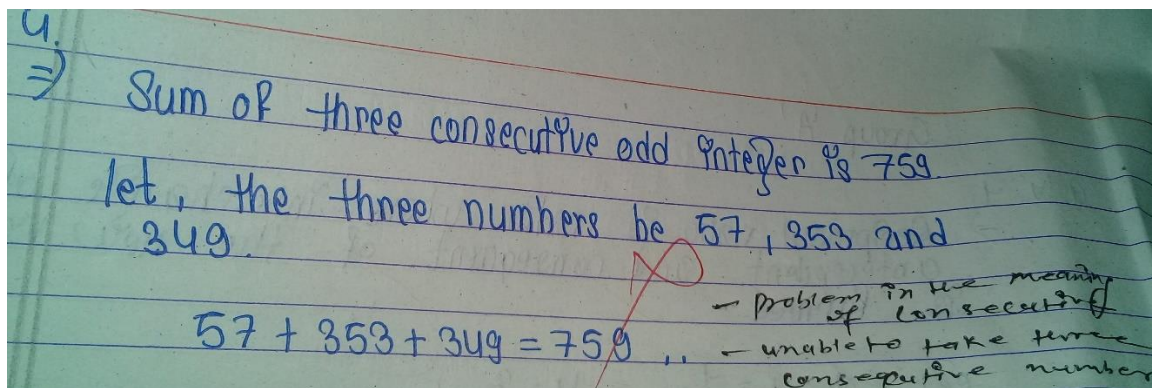One problem was; *write the expression if sum of three consecutive odd integer is 759.*

The solution of given problem was:

Let three consecutives odd integers are x, $x + 2$ and $x + 4$.

According to the question,

$x + (x + 2) + (x + 4) = 759$, which is required expression.

The way students solved the problem was:

The solution of problem given above, most of the students faced such types of difficulties. The solution shows that the students did not understand the word/ vocabulary of this question. They did not know the meaning of the word given in question such as consecutive. That's why students had written $57 + 353 + 349 = 759$. Its concluded that students known the meaning of expression, sum, odd but students unknown the meaning of consecutive. That's means students have poor vocabulary and these types of difficulties consider as language difficulties and these types of difficulties related to mathematical disability theory.

In this problem, researcher saw that only 13.33 percent students have given correct answers. This result shows that students have difficulties in word problem which have been faced by students in language while giving written test. Most of the students faced language difficulties in this problem. They did not know the meaning of the words. So, they unable to understand the problem. Without understanding impossible to solve problem i.e. without developing language ability, the solving algebraic word problem is seen almost impossible.

After that researcher took face to face interview with students and mathematics teacher to make more reliable conclusion. Researcher asked question based on guideline which is given Appendix-B and Appendix-C. Students responded as following:

Sir, I read the question easily, but in this problem, I did not know the meaning of words: consecutive and did not recognize the word and symbol. I can't understand the question what to find out.

Again, researcher conducted face to face interview with mathematics teachers. Researcher asked why students feel difficulties in word problem then teacher answered that *Algebraic word problem is one of the difficulties problems, students focus only non-verbal problem. Students have low practice in word problems. Students have poor vocabulary, meaning and not enough of pre-knowledge. In the class students easily read the problem but some students can not decide what this question say.*

As above interview, researcher identified that students have no reading difficulties because students easily read the problem, able to recognize the word and symbols. But students have language difficulties because students unfamiliar the word, unable to decide what the question say, unable to understand algebraic terms, symbols. Researcher also found students had mathematical vocabulary problem and forgetting very fast. So, researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

First of all, students must know the word meaning of any word. Without knowing the meaning of any word, they cannot easily understand the context or questions. They must know the meaning of mathematical term to solve it. Students must have the ability in their

own surrounding in order to know the meaning, mathematical terminology. For example, if they have the knowledge of circle, then they can easily solve the problem which is related to circle, if not then they cannot solve.

That's why, the teachers should construct easy questions which is already know the term, words, vocabularies and teacher should keep the words from test books and must have explain the technical difficult words in the classroom. If students don't understand the subject matter, the teacher should explain in their own language. In this way, the difficulties of students in language teacher can be minimize.

From above responses indicated that language difficulties come when students don't know the word meaning, which was used in problem so, teacher should explain technical words and use easy words while developing question.

Difficulties in Comprehension

Difficulties in comprehension means the students can read the problems clearly but can not comprehend the meaning of the word, symbol, mathematical term, question. Comprehension is the ability to understand and get the meaning of the problem. Researcher constructed three question for written test in order to find out the students' difficulties in comprehension. One question was *the difference of the present ages of two brother is 4 years, 5years ago, the product of their ages was 96, find their present ages.*

The solution of given problem was:

Let the present ages of two brother be x and y, then

$x - y = 4$ that implies $x = (4 + y)$………(i)

Again, 5 years ago, the product of their ages was 96.

i.e. $(x - 5) \times (y - 5) = 96$

or, $x\,y - 5x - 5y = 71$………..(ii)

Putting the value of $x = (4 + y)$ in equation (ii) then,

$(4 + y)\,y - 5(4 + y) - 5y = 71$

or, $y^2 - 6y - 91 = 0$ that implies $y^2 - 13y + 7y - 91 = 0$

or, $(y - 13)(y + 7) = 0$ that implies $y = 13, -7$

but age cannot be negative. So, $y = 13$.

Put $y = 13$ in equation (i) then we get $x = 17$.

Hence, the present ages of two brothers are 17 and 13.

But students solved this problem in this way:

This solution shows that students have comprehension difficulties. In this problem students assumed present age of two brother x and y and their difference is 4 so students wrote $x - y = 4$ which was correct. It is no conceptual difficulties but 5 years ago, the product of their ages was 96. So, students wrote as $x\,y - 5 = 96$ which was incorrect. Students were unable to understand the meaning of five years ago. This shows that student seem confusion in the word ago. This level of difficulties match with the definition of comprehension difficulties mentioned by the researcher Poudel (2014). That is when students can read the problems well but cannot comprehend the meaning of the words, symbols or question. This type of difficulty is considered as comprehension difficulties. And this answer paper described as students understand the problem but lack of comprehension in the meaning of the mathematical term and could not understand the relation of mathematical terms. Thus, researcher confirmed that students have comprehension difficulties and these types of difficulties related to mathematical disability theory.

Also, in this problem researcher saw that only 24.76 percent students have given correct answers. This result shows that students have difficulties in word problem which have been faced by students in comprehension while giving written test. After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

In this question I have to find out the present age of two brother so, I let present age of two brother x and y. In this question first condition easily understand but second condition, 5 years ago their age product is 96. I could not understand that relation.

In this problem students was able to read the problem correctly but unable to grasped the overall meaning of the problem. After, researcher took interview with mathematics teacher on the base of guideline given in Appendix-C and he answered that *"the students can read easily the word problem but do not understand the word problem. Students are unable to interpret the word problem into own word".*

From these interviews, researcher identified that students have no reading difficulties, but students have comprehension difficulties in those problems. Researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

Regarding this type of difficulties, the students know the problem but cannot solve comprehension related answer because of lack of while teaching to the students inside the classroom, teachers have to show different examples or non-example related to the problem. Also, teacher have to include the examples from the text book, and the questions must be based on their level. In this way, students can reduce this type of difficulties if they practice, deeply think about the solution of problem and rehearsal again and again while doing the work. In this way, the difficulties of students in comprehension can be minimize.

Above interview, it is clear that comprehension difficulties are determined if students are unable to understand the meaning of problem, unable to understand the relation of mathematical terms. Therefore, students get mistakes and these difficulties can be reduced if teacher emphasis on clear the concept, give example or non- example while teaching, and focus on more practice.

Difficulties in Formula Selection

Difficulties in formula selection means students cannot choose proper formula i.e. unable to select appropriate formula and cannot memorize or difficult to memorize. So, researcher constructed three question for written test in order to find out the students' difficulties in formula selection. The problem in this level was *if $x + \frac{1}{x} = a$ then prove that $x^2 + \frac{1}{x^2} = a^2 - 2$*. The solution of given problem was:

Given $(x + \frac{1}{x}) = a$

To prove, $x^2 + \frac{1}{x^2} = a^2 - 2$

Now, squaring $(x + \frac{1}{x}) = a$ on both sides,

$(x + \frac{1}{x})^2 = a^2$ that implies $x^2 + 2.x.\frac{1}{x} + \frac{1}{x^2} = a^2$

Hence, $x^2 + \frac{1}{x^2} = a^2 - 2$ proved.

The way of students solved this problem was:

Above solution shows that the formula selection difficulties of students. In this problem students were not managed step properly and unable to use formula $a^2 + b^2$. that's

why students wrote $(x + \frac{1}{x}) \times (x + \frac{1}{x}) = a \times a$ implies that $a^2 - 2$. This solution paper shown that they were unable to choose appropriate formula and did not decide which formula was appropriate for this problem. According to Wright (2001), if students unable to choose appropriate formula, difficult to memorization then these types of difficulties consider as formula selection difficulties. Thus, the researcher conformed that students have formula selection difficulties. Also, researcher saw that only 46.67 percent students have given correct answers. This result shows that students have difficulties in word problem which have been faced by students in formula selection while giving written test.

After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

Sir, algebra is based on symbol, notation, formula etc. there are many formulas used in algebra. I cannot memorize formula properly. I used to confuse when I select the formula. I cannot decide which formula is appropriate for which problem.

Similarly, researcher conducted face to face interview with mathematics teacher on the base of guideline given in Appendix-C and he answered that, *students have not pre-knowledge. Students have low exercise in formula. When they solve the exercise problem, they used to see formula in the book and solve the problem.*

From these interviews, the researcher identified that students have difficulties in formula selection because of students feel difficult to choose appropriate formula, memorization and used book to see formula when they solved the problem. At last

researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

These types of difficulties come from the wrong pattern of formula. If they know the pattern, then they easily memorize and generalize it. Similarly, if they know the formula of (a + b)² then they also have to know the formula of (a + b + c)². So that, first of all, students should know the pattern of formula. In this way, students can develop formula selection skills by practicing, see in the problem, using appropriate way, solving it. Also, if the students attach the formula in their room's wall, they can easily remember.

Moreover, formula selection must be guided by concept. Regarding this, students must have clear concept, Also, they should understand multiple or small pieces of concept. So, in this way, formula selection difficulties can be minimized.

From above interview, it is concluded that formula selection difficulties come when students are unable to used pattern, less practice etc. So, it can be reduced if teacher focuses more on the concept of pattern, students focus on more practice and students attach the formula in their room's wall, to remember easily.

Conceptual Difficulties

Conceptual difficulties mean students unable to find the ideas, fact, skill and cannot make the proper plan. They can not decide what to given or not and what to find out. The researcher constructed two question for written test to find out the conceptual difficulties. The question was *the cost of 2 kg mutton and 3 kg chicken is Rs. 2900. If 1 kg mutton and 2 kg chicken cost Rs 1600. What is the separate of per kg mutton and chicken? Solve it by making the pair of linear equation. Also, check the result.*

The solution of given problem was:

Let, cost of 1 kg mutton be x and cost of 1 kg chicken be y.

By the question,

$2x + 3y =$ Rs. 2900 ……..(i)

Also, $x + 2y =$ Rs. 1600

or, $x =$ Rs. $1600 - 2y$ …….(ii)

Put the value of $x =$ Rs. $1600 - 2y$ in equation (i) then

$2 ($ Rs. $1600 - 2y) + 3y =$ Rs. 2900

or, Rs. $3200 - 4y + 3y =$ Rs. 2900 that implies, $y =$ Rs. 300.

Putting the value of y in equation (ii) then,

$x =$ Rs. $1600 - 2 \times$ Rs. 300 that implies, $x =$ Rs. 1000

Checking, putting the value of x and y in equations (i) then

$2 \times$ Rs. $1000 + 3 \times$ Rs. $300 =$ Rs. 2900 that implies Rs. $2900 =$ Rs. 2900 which is true.

But students solved this problem in this way:
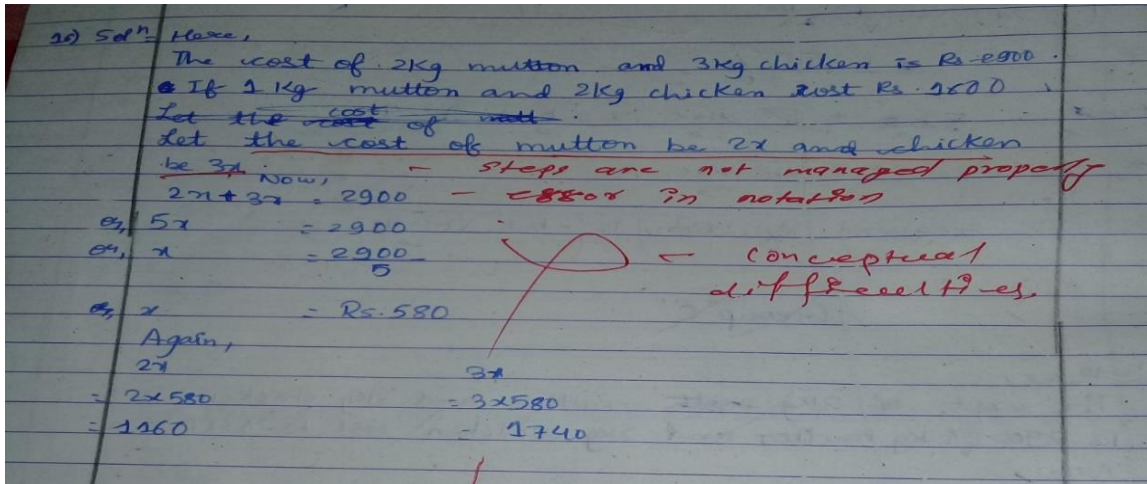
Above solution shows the conceptual difficulties of students. In this solution students assumed that different symbols 2*x* and 3*x* for per kg cost of mutton & chicken which was incorrect. They solved this problem without understanding of the question. Students unable to understand what are trying to find out. Also, students were not taking proper notation, students cannot make two equation. Students can not find the ideas and cannot make the plan. According to Polya (1957); if students don't find the information what to know and what to find out, how to relate these pieces of information and unable to make proper plan then these types of difficulties is conceptual difficulties. Thus, researcher confirmed that students have conceptual difficulties. Also, researcher saw that only 31.43 percent students have given correct answers. It also shows that students have difficulties in word problem which have been faced by students in conceptual while giving written test.

After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

I understand the word problem, but I cannot find the main ideas what is given and what to find out. I do not have ideas how to solve this problem and how to make plan.

From this interview, researcher identified that students have conceptual difficulties. Because students unable to find out the main ideas, fact and cannot take proper sign and symbols, unable to make plan. At last, researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

As we know, conceptual difficulties come due to less practices, less pre-concept/ not clear concept. Similarly, it also comes from less conceptual knowledge. So that, teachers clarify the concept. Also, while teaching about algebra (i.e. abstract subject)' teachers should visualize the concept of problem by using concrete materials for making clear concept. if the students' practice, gaining clear concept or fundamental concept, difficulties can easily minimize.

From this interview, researcher came to the conclusion that conceptual difficulties come from unclear concept of the problem, less practice, lack of pre-knowledge. And it can be reduced if students and teacher maintained above mentioned process.

Solving Process Difficulties

Solving process difficulties means when students will be able to identify the problem but do not know the procedure to carry out the operation correctly and use inappropriate method, calculation error. The researcher constructed question for written test to find out the students' difficulties in solving process. The question was *what number must be added to each term of the ratio 4:5 to make the ratio 7:8.*

The solution of given problem was:

Let the required number be x, then

$$\frac{4+x}{5+x} = \frac{7}{8}$$ that implies, $32 + 8x = 35 + 7x$

or, $8x - 7x = 35 - 32$ that implies, $x = 3$.

The way of students solved this problem was:
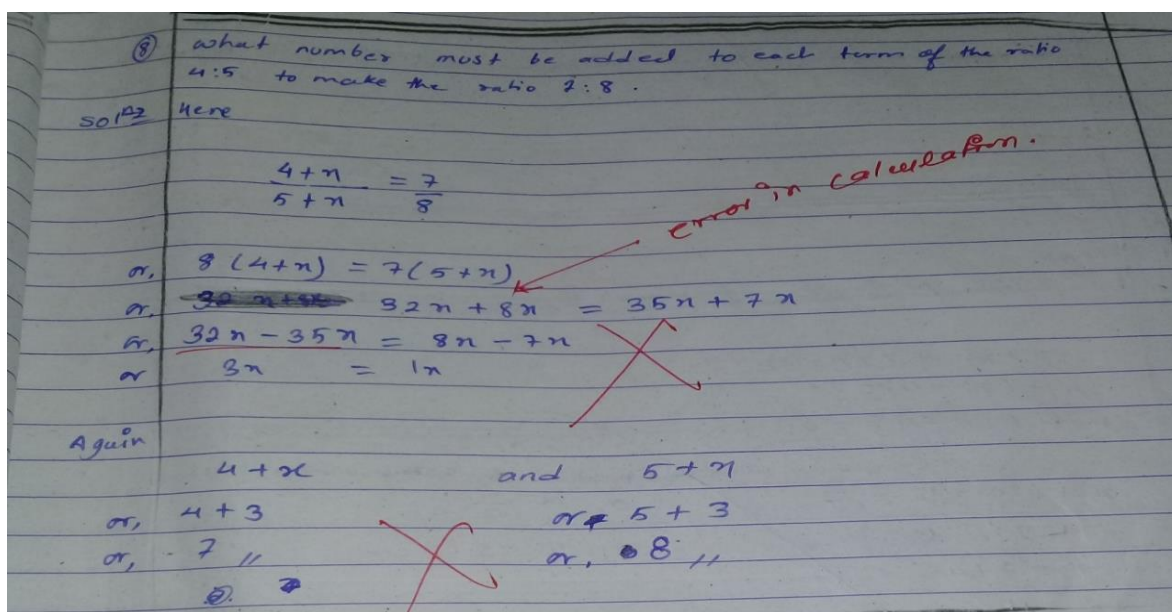
Above the solution, students assumed required number is x so, students have not conceptual difficulties. After that students wrote $\frac{4+x}{5+x} = \frac{7}{8}$. So, students have no transformation difficulties but when students did cross multiply, students wrote $32x + 8x = 35x + 7x$ which was incorrect. Students made mistake in calculation. According to Sharma (2009): if students able to identify the error operation but did not know the procedure to carry out this operation and cannot complete the operation correctly is called solving process difficulties. Thus, the researcher conformed that students have solving

process difficulties. Also, researcher saw that 80.95 percent students have given correct answers. Hence, it shows that students have difficulties in word problem which have been faced by students in solving process while giving written test.

After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

I know the BODMAS rule and in this question, I have to find the number so, I let x, and I continued the processes, but I confused in multiplication. I did mistake. Also, in the class teacher does not check homework properly(regular) and does not give any feedback.

Moreover, researcher conducted face to face interview with mathematics teacher on the base of guideline given in Appendix-C and he answered that *most of the students' participant in the class work regularly. Some of them do their homework regularly but some of them do not. In the class, students are large, so I check homework only Friday. Sometimes students make mistake in calculation, make mistake in sign when they calculate.*

From these interviews, researcher identified that students have difficulties in process because students had been able to identify the correct operation but did not know the procedure to carry out these operations correctly. At last, researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

If students have difficulties in solving process, this type of difficulties comes from lack of practices. If students unable to use appropriate method, this type of difficulties comes from lack of understanding of problem and unclear concept of the problem. So, first of all, students must be understood the problem to use appropriate method. They also must know the nature of the problem, what is given, that to find out and the relation between known and unknown. In this way this type of difficulties can be minimized.

From this interview, it is clear that solving process difficulties mainly comes from language difficulties and conceptual difficulties. If students understand the language and concept clearly then these types of difficulties may not happen again and again. And practice is more necessary to solve the problem.

Transformation Difficulties

Transformation difficulties means students understand the problem but cannot transform sentence into mathematical form. In other word students can not translate the word problem into mathematical form. They unable to use appropriate sign and symbol. So, the researcher conducted question for written test to find out the students' difficulties in transformation. The question was *one side of a triangle is half the length of the longest side. The third side is 4 cm less than the longest side. The perimeter is 21 cm. How long each side?*

The solution of given problem was:

Let the longest side of triangle be x, second side be $\frac{x}{2}$ and third side be $x - 4$.

We have given that, perimeter of triangle is 21 cm. i.e. p =21 cm

or, $x + \frac{x}{2} + x - 4 = 21$ that implies, $2x + \frac{x}{2} = 25$

or, $5x = 50$ that implies, $x = 10$ cm.

Hence, longest side of triangle (x) = 10 cm., second side of triangle ($\frac{x}{2}$) = 5 cm.

and third side of triangle ($x - 4$) = 6 cm.

But students solved this problem in this way:

From this solution, students assumed that longest side is $2x$ and another side is x

which was correct but third side, question said that third side is 4 cm less than longest

side, but students assumed third side is 4 cm only which was incorrect. That's why

students wrote perimeter of a triangle $= x + 2x + 4$ which was incorrect. In this solution

students understand the problem and have clear concept what to find out, so students

have no conceptual difficulties but students unable to write word problem into correct

mathematical form. By the definition of transformation difficulties as above types of

difficulties consider as transformation difficulties. And these types of difficulties related to mathematical disability theory.

Also, researcher saw that only 46.67 percent students have given correct answers. Thus, it shows that students have difficulties in word problem which have been faced by students in translation while giving written test.

After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

I easily understand the question. In this question, it is said that one side of triangle is half length of longest side. So, I assumed longest side is 2x and another side is x and question said third side is less than 4 cm of longest side. I understood but I can not write to correct mathematical form. I confused how can write this condition in mathematical form. So, I did mistake.

Moreover, researcher took interview with mathematics teacher on the base of guideline given in Appendix-C and *he answered that students feel difficulties in the word problem. Students easily solve the problem when question is in mathematical form. In the class I changed word problem into mathematical form then students solve those problem easily.*

From this interview, researcher identified that students have transformation difficulties because students had understood what the question was asking but did not success in developing an appropriate strategy. At last, researcher took interview with mathematics

experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

If students unable to translate word problem into mathematical form by using appropriate sign and symbol. These types of difficulties come from lack of understanding, unclear concept and unclear language. For example, if there is age problem of father and son, teacher should make clear the concept of ago means subtraction, after means addition and times means multiplication etc. to the students. Also, teacher should translate word problem into mathematical form and mathematical sentence into word problem. After all, teacher should display the solution of problem and make students engage in solving problem. As whole these difficulties come if students have language difficulties and conceptual difficulties.

Hence, it is concluded that these difficulties come from mainly less of practice, unknown sign and symbols, misunderstanding, and unclear concept. So, it can be minimized if teacher and students maintained above mentioned process.

Difficulties in Solving Equation

In algebra, when two algebraic expressions combine with equal sign (=) is called equation. Difficulties in solving equation refers to unable to solve the equation with use proper rules and method. Also, difficulties in side change sign change rule, difficulties in substitution.

So, researcher constructed a question for written test to find out the students' difficulties in solving equation. The question was *the breath of rectangle is one-third of*

its length. If perimeter of rectangle is 32 then find length and breath. Also, find the area.

The solution of given problem was:

Let the length of rectangle be x then breadth of rectangle be $\frac{x}{3}$

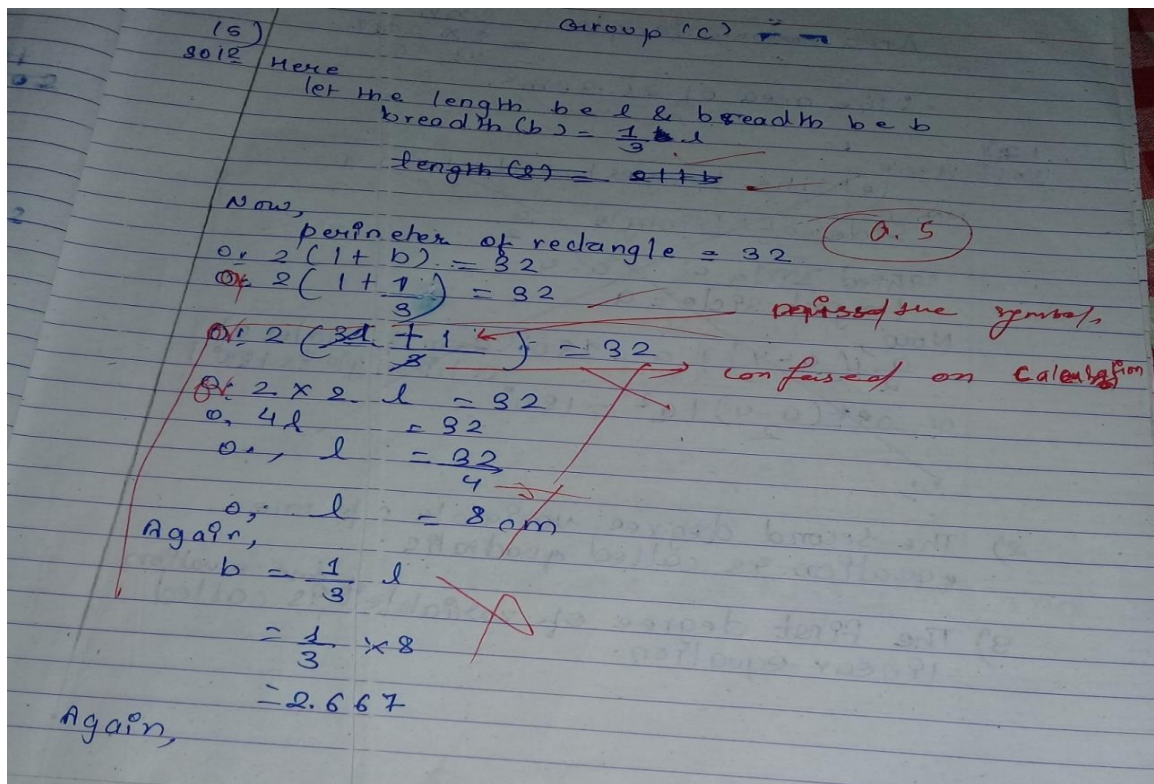We have given,

Perimeter of rectangle (p) = 32 that implies, $2 (l + b) = 32$

or, $2 (x + \frac{x}{3}) = 32$ that implies, $2 \times 4x = 32 \times 3$ that implies $x = 12$ cm.

Hence, length of rectangle is 12 cm and breadth of rectangle is $\frac{12}{3} = 4$ cm.

Again, area of rectangle(A) $= l \times b$ that implies, $12 \times 4 = 48$ cm²

The way of students solved this problem was:

From these solution students assumed that length l and breath $\frac{l}{3}$ which was correct but when students were calculated students put the value of b equal to $\frac{1}{3}$ which was incorrect i.e. students did mistake in substitution. After that students wrote $2\left(\frac{3l+1}{3}\right) = 32$ *implies* $2\times2l= 32$ which was incorrect. As above these solution shows that students have no conceptual difficulties, no transformation difficulties and no comprehension difficulties. But students did make mistake in substitution also students confused in calculation. Above problem related to constructivist theory. This theory indicated that learning is an active process in which learners construct new ideas or concept based upon their current or past knowledge.

Also, researcher saw that only 57.14 percent students have given correct answers. Thus, it shows that students have difficulties in word problem which have been faced by students in solving equation while giving written test.

After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

In my view equation is a statement of an equality containing one or more variables, use equal (=) sign. But sir I have problem in substitution, simplification also, I faced difficulties int side change and sign change rule.

From this interview, researcher identified that the students have difficulties in solving equation because students were feeling uneasy and confused in solving equation and low performance students were unknown about side change-sign change rule. At last,

researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

In mathematics, there are mainly two types of knowledge i.e. conceptual knowledge and procedural knowledge. First, students must understand the variable and constant in side change rule. While solving equation, they separate one variable in one side and constant in another side. When constant and variable exchange their side, then their sign will also change. Here, sign change is conceptual knowledge and problem which is solved is procedural knowledge. Therefore, both are necessary for equation solving. Regarding the solving of this types of difficulties, students have the knowledge of balance of two things. Also, students face difficulties in sign change rule and putting appropriate value because of becoming nervousness. That's why, while choosing appropriate value, students should be carefully.

Moreover, there are two variables equation problem in grade nine. So, first teacher explains the clear concept of two variables and teach how to transfer two variables equation into one variable. After finding the value this variable then finds the value of another variable. Therefore, students must have the knowledge of these types of problems and teachers should teach effectively. So that, until students don't know this knowledge, they cannot solve substitution related problem.

Thus, from above responses it is indicated that equation solving difficulties come from unclear concept of variable & constant, students' unknown sing change rule, less practice and students take hasty decision to substitute the values. So, these difficulties can be minimized if teacher make clear the concept of variable & constant when he/she teach, sign change rule and students choose the value carefully and focus on more practice.

Difficulties in Transition from Arithmetic to Algebra

Transition from arithmetic to algebra means the nature of the problem present in arithmetic and algebra and different procedure used to solve this problem. It means transition from known quantity to unknown quantity as the transition from arithmetic thinking to algebraic thinking.

Difficulties in transition from arithmetic to algebra means students unable to solve this type of problem. Researcher constructed a question for written test to find out the students' difficulties in transition from arithmetic to algebra. The question was *a rectangle has length and breadth (3x – 4) cm and (x + 1) cm respectively, find the area of the rectangle.*

The solution of given problem was:

Given that**,**

Length of rectangle (l) = ($3x - 4$) cm and breadth (b) = ($x + 1$) cm.

Area of rectangle (A) = ?

We know that,

$A = l \times b$ that implies, ($3x - 4$) cm × ($x + 1$) cm.

= ($3x^2 - x - 4$) cm².

But students solved this problem in this way:

From these solution, students wrote formula $A = l \times b$ that implies $(3x - 4) \times (x + 1)$ which was correct. It means students have no transformation difficulties but when they multiplied students wrote $3x^2 - 7x - 4$ which was incorrect. In this solution students did mistake in calculation i.e students did mistake $3x \times 1 = -3x$. Also, students done oversimplification which matched the definition of difficulties in transition. In this problem students did not look back. If they looked back then they had identified the mistake and done again (Polya, 1957). So, researcher conformed that students have difficulties in transition from arithmetic to algebra. And these difficulties related to theory of mathematical disability associate manipulation of algebraic problem with appropriate rules, procedures and mathematical calculation. Also, researcher saw that only 67.62 percent students have given correct answers. Thus, it shows that students have difficulties in word problem which have been faced by students in transition while giving written test.

After that researcher took the face to face interview with students. Researcher asked question based on guideline which is given Appendix-B. Students responded as following:

I know transition arithmetic to algebra, but I confused to translate arithmetic rule into algebra. I easily multiply if length and breadth of rectangle are 6cm and 4cm. but I confused if length and breadth is variables form.

From this interview, students didn't get proper idea to solve the problem where the faced problem related to generalization, translation. So, researcher identified that students have difficulties in transition from arithmetic to algebra. Researcher took interview with mathematics experts to minimize these difficulties based on guideline given in the appendix-D. The experts responded as following:

Due to the less understanding, students cannot generalize arithmetic rule in algebra, addition, subtraction, multiplication and division of algebraic term. So that, teachers should make clear concept of algebraic expressions' addition, subtraction, multiplication and division. For example, if students able to solve $2 \times 4 = 8$ but they cannot solve $(3x - 4) \times (x + 1)$ easily. This type of difficulties comes from lack of understanding, pre-knowledge and basic concept of algebra. So, to solve these, teacher should make clear the concept of algebraic expression such as add, subtraction, multiplication and division. In the same way the knowledge of law of indices should be provide to the students before starting class.

From the above responses, it is identified that transition difficulties come from misunderstanding of the arithmetic rule in algebra, unclear concept of algebraic expression, less practice, and unknown the law of indices. So, it can be minimized if teacher and students maintained as above.

Chapter V

Summary, Findings, Conclusion and Recommendations

In this chapter researcher discussed about the summary of this study with major finding and conclusion. And last section researcher presented recommendation for further study.

Summary of the Study

This is a study on "Students Difficulties in Solving Algebraic Word Problem at Secondary Level." The objectives of this study were to identify and find the ways of minimizing students' difficulties in solving algebraic word problem at secondary level. Also, researcher used embedded mixed method design. The major tools used achievement test and interview schedule is used for this thesis. The researcher selected two school. Among them, one was community, and another was private school in Kathmandu district to fulfil the objective of this study. An achievement test was conduct in 105 students of class IX of Mangal H.S.S. and Hill Town B.S. Kirtipur, Kathmandu. After checking the answer sheet and researcher saw high difficulties in given problem to the students. So, researcher selected 10 students having low performance according to test result which was given appendix-F and two mathematics teachers for interview. Also, researcher selected three mathematician experts for interview for find out the possible way of minimizing students' difficulties. Obtained data from test was analyzed by using percentage. Similarly, obtained data from interview was transcribed by verbally using general inductive approach. Triangulation is used for the validity of the data and to support the finding of the study mathematical disability theory was used.

Many students have difficulties in solving algebraic word problem because of poor vocabulary, unclear concept, lack of the understanding of mathematical term. Also, students do not sufficiently practice word problem. Students unable to generalized arithmetic rule in algebra.

Findings of the Study

After the analysis and interpretation of obtained data, the following findings were obtained which were listed below**:**

- From the result, there are no reading difficulties in the students of private schools and community schools.

- The analysis shows that students gives correct answer in language related questions 13.33%, in comprehension difficulties related questions 24.76%, formula selection difficulties related question 46.67%, conceptual difficulties related questions 31.43%, in solving process difficulties related questions 80.95%, transformation difficulties related questions 46.67%, equation solving difficulties related questions 57.14% and transition difficulties related questions 67.62%.

- Most of the students unable to understand the word meaning owing to their poor vocabulary. So, these types of difficulties can be minimized if teacher construct easy question in which word should be familiar to text book. Also, teacher explain the technical word. Teacher should give task to memorize vocabulary words repeatedly.

- Most of the students unable to understand the mathematical meaning of the words, problems and unable to interpret information into own word. So, these

types of difficulties can be minimized if teacher construct question on their level, give suitable example while teaching, and students focus on practice, deeply thinking, rehearsal again and again while doing the homework.

- Students feel difficulty to memorize formula, unable to choose appropriate formula, unable to know pattern of formula. So, teacher explain pattern of formula while teaching, develop the generalize the concept of formula. Also, students attach the list of formula in their room's wall in order to memorize easily.

- Most of the students unable to find the main ideas from the problem, unable to make proper plan, cannot make clear concept. So, teacher should make clear concept, visualized the problem by using concrete materials when he/she teach. Also, students focus on more practice.

- Most of the students unable to choose appropriate method, incomplete calculation, error in calculation. So, students focus on more practice and teacher should be clear concept of mathematical term, nature of the problem for minimizing these difficulties.

- Most of the students unable to translate word problem into correct mathematical form by using proper sign and symbol. Similarly, not know when irrelevant information included or when information is given out of sequence. So, these difficulties can be minimized if teachers make the clear concept to the students. Teacher should display to translate word problem into mathematical form and reverse also. And focus on practice.

- Misunderstanding of equation solving method, rule and procedures, incomplete calculation, mistake in substitution were most familiar difficulties in solving equation. So, first teacher should make clear the concept of variable and constant, and students choose the value carefully, know the sign change rule.

- Lack of knowledge about using arithmetic rules in algebra properly, problem in generalization of arithmetic rules in algebra, problem in moving from arithmetic to algebra strategy for solving algebraic problem. So, teacher should make clear concept of algebraic expression, low of indices and focus on more practice

- Students did not have enough practice of mathematics at home. So, it is necessary for students focus on more practice for solving algebraic word problem.

Conclusion

From the above finding, it is concluded that students have faced many difficulties in solving algebraic word problem due to inability in giving meaning of mathematical term, poor vocabulary, lack of pre-knowledge. Also, students have lack of understanding and students can not make clear the concept of the problem about the problem. And students are not familiar with rule of multiplication, law of indices. Similarly, students do either incomplete solution or do over simplification. And students have not clear concept of algebraic sign, symbol and language. So, students unable to translate word problem into mathematical form. Moreover, students have less practice of mathematics and unable to know the pattern of formulas.

These difficulties can be minimized if teacher should clear the concept to the students. Algebra is abstract so, when he/she teaches then he/she must be use concrete

materials to clear concept. Similarly, at the time of teaching formula, teacher must be use pattern. Students should more focus on practicing word problem. Also, to concentrate and clear the concept about the topic to students, it is better to provide basic knowledge for teacher.

Recommendations of Further Study

Basis of above findings and conclusion the researcher suggested that some recommendations which as following:

- Teacher must be used technology to clear the algebraic concept.

- Teacher must check the homework regularly if he/she found any mistake then he/she give feedback in front of students immediately.

- The study area of this research should be extended like other development region and other parts of country.
  Research in same topic with different tools and method.

- Recommends for research as *"Comparison of Achievement in Algebraic Word Problem between the Students of Government school and Private school"*.

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Question Paper for Written Test

Sub : C. Mathematics   **F.M: 40**

Class : IX   **Time: 1:30**   **P.M: 16**

Group "A"   [10×2=20]

  1. What is reciprocal ratio? Give one example.

  2. Define quadratic equation with example.

  3. Define the linear equation with example.

  4. Write the expression if sum of three consecutive odd integer is 759.

  5. If 4, x and 18 are in continued proportion, find the value of x.

  6. The letter n represent a natural number, what is more $1/n$ or $1/(n+1)$? How do you

    know?

  7. If twice a number is decreased by 4 the result is 26 then what is a number?

  8. What number must be added to each term of the ratio 4:5 to make the ratio 7:8.

  9. A rectangle has length and breadth $(3x – 4)$ cm and $(x + 1)$ cm respectively, find

    the area of the rectangle.

  10. If $x + 1/x = a$ then prove that $x^2 + 1/x^2 = a^2 - 2$

Group "B"   **[4×3=12]**

11. Show that the quadratic equation $ax^2 + bx + c = 0$ has two roots.

12. The natural numbers are in the ratio of 2:3 and the difference of their square is 320. Find the numbers.

13. One side of a triangle is half the length of the longest side. The third side is 4 cm less than the longest side. The perimeter is 21 cm. How long each side?

14. The difference of the present ages of two brother is 4 years, 5years ago, the product of their ages was 96, find their present ages.

Group "C"   **[2×4=8]**

15. The breath of rectangle is one-third of its length. If perimeter of rectangle is 32 Then find the length and breath. Also, find the area.

16. The cost of 2 kg mutton and 3 kg chicken is Rs. 2900. If 1 kg mutton and 2 kg chicken cost Rs 1600. What is the separate of per kg mutton and chicken? Solve it by making the pair of linear equation. Also, check the result.

Appendix-B

Interview Schedule

Name of Student:……………………   Gender:………

Roll no: …………….   Class:…….

The interview with mathematics students will take on the basis of following topic:

Reading and Language Difficulties

➢ Unfamiliar word and Vocabulary

➢ Reorganization of word and symbol

Conceptual Difficulties

➢ Understanding of word problem

➢ Identify the main ideas

➢ Connection among these ideas, fact and skill

Difficulties in Comprehending Variable in Algebra

➢ Interpret the word problem into own word

➢ Use operation of variable and constant

➢ Translate the word problem into mathematical statement with proper sign and symbol

Difficulties in Transition from Arithmetic to Algebra

➢ Use arithmetic rules in algebra properly

Solving process Difficulties

➢ **BODMAS** rules

➢ Work out the question. Tell me what you do as you proceed

Transformation Difficulties

➢ Interchange the value and unfamiliar words

➢ Mathematical terminologies

Difficulties in Equation

➢ What is equation?

➢ Substitute the values and simplify properly

Difficulties in Formula Selection

➢ Memorization of the formula

➢ What are the problems you face to select the formula?

Appendix-C

Interview Schedule with Mathematics Teacher

Name of Teacher:…………………….   Gender:……

Teaching Experience:…………   Class:…….

The interview with mathematics teacher will take on the basis of following topic:

➢ Pre-knowledge of students in Algebra

➢ Use of teaching materials in class

➢ Students participation in class

➢ Students-students and students teacher relation

➢ Students practice of algebra at home or class

➢ Teaching learning strategy in algebra

➢ Reinforcement, feedback in the class

Appendix-D

Interview Schedule with Mathematics Experts

Name of Expert:…………………….

Teaching Experience:…………

The interview will take with mathematics export on the basis guideline:

Language Difficulties

➢ word meaning

➢ vocabulary

➢ terminology

Comprehension Difficulties

➢ interpret the information into own word

➢ related example and non-example

Conceptual Difficulties

➢ to find the main ideas

➢ unable to what to known and what to be find

Formula Selection Difficulties

➢ memorization formula

➢ selection of formula

Difficulties in Equation Solving

➢ Sign change rule

➢ Value substitution.

Difficulties in Transition from Arithmetic to Algebra

➢ generalize arithmetic rule in algebra

Transformation Difficulties

➢ Use of appropriate sign and symbol

➢ translate word problem into mathematical form

Difficulties in Solving Process

➢ Use propriate method

➢ calculation error

Appendix-E

Reliability of test by Using Split Half-Method

S.N. of Student	Score on Odd Number(X_o)	Score on Even Number(Y_e)	$X_o{}^2$	$Y_e{}^2$	X_oY_e
1	16	18	256	324	288
2	17	16	289	256	272
3	17	17.5	289	306.25	297.5
4	19.5	20	380.25	400	390
5	18	17	324	289	306
Total	$\sum X_o$=87.5	$\sum Y_e$=88.5	$\sum X_o{}^2$=1538.25	$\sum Y_e{}^2$=1575.25	$\sum X_oY_e$=1553.5

$$\mathbf{r_{oe}} = \frac{N\sum X_oY_e - \sum X_o\sum Y_e}{\sqrt{[N\sum X_o{}^2 - (\sum X_o)^2\ [N\sum Y_e{}^2 - (\sum Y_e)^2]}}$$

$$= \frac{5\times1553.5 - 87.5\times88.5}{\sqrt{[5\times1538.25 - (87.5)^2][5\times1575.25 - (88.5)^2]}}$$

$$= 0.605$$

Now,

$$\text{Reliability of full test } (r_t) = \frac{2r_{oe}}{1+r_{oe}}$$

$$= \frac{2\times0.605}{1+0.605}$$

$$= 0.75$$

According to **Garret, 2008**

0.0 to ± 0.20	Negligible
± 0.20 to ± 0.40	Present but slight
± 0.40 to ± 0.70	Substantial or marked
± 0.70 to ±1.0	High to very high

Appendix-F

Students mark-sheet which obtained mark in achievement test:

S.N.	Full mark	Obtained mark	S.N.	Full mark	Obtained mark	S.N.	Full mark	Obtained mark
1.	40	31	36.	40	14	71.	40	8.5
2.	40	29.5	37.	40	14	72.	40	8
3.	40	29.5	38.	40	14	73.	40	8
4.	40	29	39.	40	14	74.	40	8
5.	40	28	40.	40	13.5	75.	40	8
6.	40	27.5	41.	40	13.5	76.	40	7.5
7.	40	26	42.	40	13.5	77.	40	7
8.	40	23.5	43.	40	13	78.	40	7
9.	40	23	44.	40	13	79.	40	7
10.	40	23	45.	40	12.5	80.	40	7
11.	40	23	46.	40	12.5	81.	40	7
12.	40	22.5	47.	40	12.5	82.	40	6.5
13.	40	22	48.	40	12	83.	40	6.5
14.	40	21.5	49.	40	11.5	84.	40	6
15.	40	20	50.	40	11.5	85.	40	6
16.	40	20	51.	40	11.5	86.	40	5.5
17.	40	19.5	52.	40	11.5	87.	40	5.5
18.	40	19.5	53.	40	11	88.	40	5
19.	40	19	54.	40	11	89.	40	5
20.	40	18.5	55.	40	11	90.	40	5
21.	40	18.5	56.	40	10.5	91.	40	4.5
22.	40	18	57.	40	10.5	92.	40	4.5
23.	40	17.5	58.	40	10.5	93.	40	4
24.	40	17	59.	40	10.5	94.	40	4
25.	40	17	60.	40	10	95.	40	4
26.	40	16.5	61.	40	10	96.	40	3.5
27.	40	16.5	62.	40	10	97.	40	3.5
28.	40	16	63.	40	10	98.	40	3.5
29.	40	16	64.	40	9.5	99.	40	3
30.	40	15.5	65.	40	9	100.	40	3
31.	40	15.5	66.	40	9	101.	40	3
32.	40	15.5	67.	40	9	102.	40	2.5
33.	40	15	68.	40	8.5	103.	40	2.5
34.	40	14.5	69.	40	8.5	104.	40	2.5
35.	40	14.5	70.	40	8.5	105.	40	2