

Chapter I

Introduction

Background of the Study

Mathematics is an essential part of academic field. Mathematics plays the vital role in the development of human activities. Mathematics is a mirror of all the civilization. Each subjects are inter related with mathematics contain. Mathematics is a fundamental course for further study and importance for daily life. (Acharya,2015)

Students are facing many challenges while learning mathematics. These challenges are related to contain, teaching materials, teaching strategies as well as pedagogical knowledge and so on. Home environment, economical condition of family, geographical structure of situated area and age of students play the vital role for learning mathematical knowledge. There are various affecting factors such as: Classroom management, facilities available in classroom, number of students' teacher's qualification, location of school and so on.

Therefore problems that occur in learning mathematics are the main concern in the present education. Problems may occur in any contents like sets, arithmetic, mensuration, algebra, trigonometry, statistics, geometry and probability. Learning is a modification of behavior, changing of knowledge, skill, interest and attitude. According to skinner "learning is a process of progressive behavior adaptations".

"Mathematics provides the knowledge, mathematics is the body knowledge and information related with the concept of quantity, structure, space and change is also the academic discipline that studies them." (Michaels, Grossman and Scott, 1967) *"Mathematics is the science, which draws necessary conclusion."*(Pierce)

"Mathematics is a free innovation of the human intellect." (Einstein)

In present problems are widespread in secondary level mathematics. In Nepal, secondary level refers to grade nine to twelve. Generally, students age 13 to 16 are enrolled in this level and mathematics has been taught as a core subject as well as optional subject. The class weightage of grade nine and ten is six periods in a week and full marks is hundreds of both classes. According to data of SLC (before 2072 but now SEE) result many students was weak in mathematics and many researchers gave the results students are facing the various problems in learning mathematics.

Generally, students feel difficulties in learning mathematics related to understanding the new concept and its relation. Teacher's readiness and interest in teaching are also importance for teaching learning activities as well as developing the positive attitude in the students towards mathematics learning. (Kamber & Takaci ,2018)

Problems in mathematics are determined by the nature of course content, background of student, culture of student, teaching method and teaching materials. Other aspects which raise the problem to students are beliefs of mathematics teacher, students and parents' society. Students have been facing various difficulties while learning mathematics. So this study aims to find out the difficulties faced by the students in learning trigonometry at grade X.

Trigonometry is a branch of mathematics that studies the relationships between lengths and angles of triangles. This field emerged in the Hellenistic world during the 3rd century BC from applications of geometry to astronomic. Trigonometry is a one of the fundamental area of mathematics. Trigonometry is effective and useful in the daily life of human being. It is useful for measuring the

height and distance. It is really useful to measure the length of shadow and height of any object from the horizontal line.

Similarly, some other usefulness of trigonometry is it is used in oceanography for calculating the height of tides in oceans. The sine and cosine functions are fundamental to the theory of periodic functions describe the sound and light waves. Trigonometry has also its applications in satellite systems. One of the most important fields of mathematics is especially for career. Which is built around calculating angles, a working knowledge of trigonometry and its uses is important for students of all ages with consistent study. Trigonometry develops the critical thinking power of students in any content. Students become able to learn many ways of problem solving of mathematics after studying the trigonometry content.

Statement of the Problem

Formulating the research problem is the first and most importance step in the research process. In general, statement of the problem outlines the basic facts of the problem. Learning is a lifelong process where learners faces many problems and challenges while learning.

When I was studying in grade X I had understood trigonometry very slowly which was the main part of the optional mathematics. I got low mark in trigonometry as the period of examination. I have five 5 years' experience in the teaching field at secondary level as a mathematics teacher. Most of the students did mistake in trigonometry's questions in the period of exam. Students were very poor in optional mathematics than other elective subject in school level. Last year, I checked some answer sheets of SEE, I saw many mistakes in trigonometry part than other contents of optional mathematics. Most of the students they left question these were related to

trigonometry but they solved other questions. Almost students told optional mathematics is difficult because of content of trigonometry. So I became interested to do research on the topic 'difficulties of students in learning trigonometry'.

Objectives of the Study

Anybody can't meet the destination point without objectives. Any peoples can complete any kind of the work if he/she carries the defined objectives. The objectives of this study were as follow:

- To find out the difficulties of students in learning trigonometry at grade X.
- To explore the remedies of difficulties of students in learning trigonometry at grade X.

Research Questions

Research questions help to obtain the research objectives. A research question shows clearly that what kind of problems want to solve by researcher. The research questions of this study were as follow:

- What are the difficulties of students in learning trigonometry?
- What are theremedies to reduce the difficulties of students in learning trigonometry?

Significance of the Study

Every research is importance because it gives detail of various unseen facts in any area of study. Mathematics is one of the most essential and importance subject. It has been taught as a compulsory subject up to class ten. Mathematics is fundamental subject for any student who wants to study science, management, engineering, hotel management and so on. There are learner's diversities in every classroom such as

diversities in interest, capacity, need, age etc. Different students have different interest and choice. Mathematics achievement is a major factor for every student to his/her career. Mathematics connected to every sector, every field. Any field of higher education can't be complete without mathematics. Trigonometry is also the one of the main and importance unit of the school and campus curriculum. Result of this research really helps to teacher as well as students in every leaning activity.

Moreover, this section on significance of study provides information about how this study contributes to all. Similarly, every research provides the deep and new knowledge on the topic of research. Research of any topic is the get way for further research, it opens the door to do research in the related area. Every research has its own importance and Significance. The main significances of the study are as bellow:

- This study helps to researcher to find the difficulties of students in learning trigonometry.
- It is beneficial able for policy makers and curriculum makers to maintain the policy as well as revise the curriculum.
- It really helps to the teacher for selecting the teaching method and materials according to student's interest and capacity.
- It is helpful to mathematics educators and teachers to construct the different models on trigonometry learning.
- It provides appropriate guideline to teacher and students for teaching and learning process on trigonometry.
- It helps to researcher for further related research on the topic trigonometry.
- This study provides the ideas how to minimize the learning difficulties of students' etc.

Delimitation of the Study

Delimitation is the process of setting the boundaries for the research topic but I completed the research on the topic difficulties of students in learning trigonometry in Kathmandu district. According to the researcher's time and cost the delimitations were as follow:

- This study was related to difficulties of students in learning trigonometry at secondary level (grade X) of Kirtipur Municipality only.
- The study covered only trigonometry part only of optional mathematics of grade X.
- This study was limited to 155 students from the four secondary schools of Kirtipur Municipality.
- Three mathematics teachers of secondary level those were teaching optional mathematics included in study.
- The difficulties of students in learning trigonometry explored by the help of achievement test with students and interview guide lines with five students and three Mathematics teachers.
- Three mathematics experts and three teachers were taken to get the remedies of difficulties.

Operational Definition of Key Terms

Key words mean those words which play the vital role for conducting the research work. I defined some of the words of my research which are as follow:-

Learning trigonometry. In this study, learning trigonometry means being able to understand the concept of trigonometry which is included in the course of grade X, solve the problems base on those concepts .When students able to find

remaining sides and angles of triangle if one side and one angle is given of right angle triangle, able to solve the problems related to height and distance. Similarly, able to use formula of sub-multiple and multiple angle for simplify the trigonometric problems is called learning trigonometry.

Students.In the study students means these were studying optional mathematics in grade X of Kirtipur Municipality in the year 2075.

Students' activities.In the study students activities refer class participation of students, class work, conversation with teacher, coordinating with class-mates about related topic and discussion about out questions related to trigonometry content etc. All behavior of the students under the rules and regulations had made by school administration are called students activities.

Teachers.Teachers those were teaching optional mathematics in secondary level of selected school of Kirtipur Municipality in the academic year 2075.

Pre-Knowledge.In this study pre-knowledge referred those students' knowledge about right angle triangle, knowledge about trigonometry ratio and some trigonometric formulae. Knowledge about solving process of linear and quadratic equation, knowledge about geometry and algebra refers pre-knowledge.

Difficulties. In that study difficulties refer students who were unable to understand the process of simplify trigonometric problems as well as solving process of trigonometry equation. Moreover, those students who were unable to understand the problem solving steps and figure in height and distance. If student unable to apply same process or same formula in different situation it is called difficulties in learning mathematics.

Chapter II

Review of the Related Literatures

Literature review is an essential for complete the study which provides strong knowledge about the related topic. A literature is a process of obtaining, reading and evaluating the research literature in the area of the research. The main purpose of review of related literature is what is already known, what are the topics can be develop for further research. Normally to review the literature we use books, articles, journals and internet for the resources .It gives the some ideas for make tools, use the tool, collect the data, analysis and interpretation the data. Mainly, it helps to conduct the research in a systematic way of by providing the general outlines of the study.

The review of the related literature involves the identification and analysis of document related to the study. We can get many ideas about how to make a research design for suitable research. There are two types of literature one is empirical literature and another is theoretical literature. The empirical literature includes that for the any research what kind of tools used by researcher, how researcher collected the data, method of analysis, total time taken by researcher etc. The theoretical literature refers that what kind of learning theory can apply for this research.

Empirical Literature

Teaching is a global phenomenon and learning is an individualized process. Many problems arise in the teaching learning process.

Ghimire (2013), conducted research entitled “Difficulties of bote students in learning mathematics”. This study was based on case study research design. There were two objectives of this study as to identify the difficulties of Bote students in

learning mathematics at lower secondary level and to analyze major cases of difficulties in learning mathematics. To fulfill these two objectives he, used in-depth interview with selected Bote students. He interviewed with their teacher and parents and observed the classroom activities. Data were collected by interview schedule and observation form, these were the tool of data collection procedure. Only four students of class seven were selected for interview. He included in depth interview with problematic children with their parents and teacher.

As well as he observed home environment of these students for collecting the data. When he went to school and at home of these children's he recorded the voice while taking interview for original data. The responded of this study were Bote students, their parents and the mathematics teacher. The record of the interview of the students and parents, observation of the students was transcribed properly. The collected information's categorized in different heading and sub-heading. He developed some indicator to identify the case of difficulties. These difficulties were related to students' cultural background, interaction and motivational, socio-economic condition and parental involvement.

He found that Bote students' cultural background plays the vital role in their mathematics learning. Bote students could not get sufficient time for the mathematics practice at home. Bote parents had low education status which direct impact on their childrens learning outcomes. Most of the Bote students did not complete the homework and low participation in class room .It is found that in spite of go to school, some of Bote children were found interested to go work. From the above review, I concluded that difficulties come at that time when student's participation is low in school, students give more interest to do work than study.

Bhat (2017), carried out the research entitled “Problem faced by students in learning set”. The main objectives of that survey were to find problem faced by students in learning set at grade X and to compare the problem faced by boys and girls in learning set at grade X. Descriptive survey research design was adopted to conduct the study. He selected the 500 students of grade X of Baitadi district. The researcher selected 10 schools by random sampling from total population. Questionnaire and interview was the tool of data collection. Mean weightage was used to determine the problems faced by students in learning the content of set and z-test was applied to compare the problem between the boys and girls.

He found that most of the students faced the problem due to the content as the verbal problems of set are difficult. Teachers were exam oriented only and they didn't use students centered method while teaching, lack of group discussion, lack of exercise book and lack of use electronic instructional materials were main problems.

I concluded that main difficulties of students to learn any types of content are lack of group discussion, lack of teacher centered method, lack of book and materials for practice mathematics. If we decrease these difficulties /problems than students can learn the contents.

Bhatta (2017), conducted a Master's degree thesis entitled “Problem faced by mathematics teacher at basic level in teaching geometry”. The main objectives of that survey were to identify the problems faced by mathematics teacher at basic level teaching geometry and to explore the causes of the problems faced by mathematics teacher in teaching geometry. Three research question were made .Data were collected by described survey method to 100 teachers among them 57 were male and

43 were female teachers of bhakatapur and lalitpur districts. The five point likert rating scale was used in administering it and it was analyzed by using mean weightage.

He found that school administration is irresponsible to manage and construct the necessary teaching materials and text books. Text book were not well planned not sequential. Lack of reference book and teacher guide, lack of laboratory in school, curriculum is urban oriented, students evaluation technique were main problems. Teaching strategies as well as teaching materials were in traditional system.

Gautam (2017), conducted the master's thesis on the topic "Tamang students' learning difficulties in mathematics". I reviewed this thesis written by Binod Gautam from Mahendra Ratna Campus tahachal, Kathmandu. Main objectives of this study were to explore the causes of learning difficulties of tamang students at primary level and to identify impact of home environment of tamang students to learn mathematics at primary level.

Two research questions were made for conducting the research. These questions were what are the causes of learning difficulties of tamang students at grade V? How is the home environment in learning mathematics? Case study research design was applied to get the answer of this research question. The study was conducted among the five tamang students studying at grade V. The research tools were interview schedule and observation guideline for this study.

Moreover, the survey was conducted by taking all the tamang students of Kathmandu district of class five. Only five tamang students were selected for sample among them four were girls and one was boy of class five, where purposive sampling was used. The data and information were collected by using interview guideline and observation guideline. The collected data was categorized according to the category of

the responded. The categories were students, mathematics teacher, parents of the students. The researcher took individual record of tamang students' thorough interview schedule. The data analysis was interpreted by using frame work the researcher developed and with the theory in literature review.

He found that tamang students used their mother tongue first and nepali language as a second language there were language discontinuity at home and school. There were no proper interaction between tamang students and mathematics teacher in class. Lack of interpersonal relation between tamang students with each other in the classroom is main problem among tamang students. Lack of the local teacher at school, home and school environment is not suitable for the learning mathematics.

Similarly, I reviewed the next thesis on the topic "Students Difficulties in Proving Theorms of Geometry". This thesis carried out by "yadav 2017". The objectives of the study were to explore the difficulties of students in learning geometry and to analyze the causes of difficulties in learning geometry. The study was based on the case study method design the researcher selected two government schools of Nuwakot district. The criteria of selecting students were different ethnic group, gender. The study was included the students of grade IX only. Hundred students were participated. Achievement test, interview schedule, classroom observation note were used to collect the data in this study. The researcher observed mathematics of class IX regular for 30 days during teaching learning activities and exam were taken 50/50 students of both schools.

Interviewed were taken from two mathematics teachers, two head teacher and six students too. The researcher had listened the reply of respondents curiously and noted properly and analyzed. The findings of this study were difficulties in proving

theorem of geometry due to the lack of pre knowledge, lack of knowledge about angle, lack of basic concept of geometry. As well as lack of appropriate method of geometry learning, subject matter of geometry are limited in the text book, lack of practice examples and project work were main difficulties.

Moreover, I reviewed one international journal on the topic “Factors Affecting Difficulties in Learning Mathematics by Mathematics Learners”. This international journal conducted by Acharya (2017). The main purpose of this study was to explore the causes of learning difficulties in mathematics. . The design of the study was qualitative. He observed the Classroom of three schools of Arghakhanchi district and interview had taken to the research participants. He selected purposively were Arghakhanchi district and mathematics teachers their children, head teachers and parents. During the study, it has not disclosed the participant’s real name to follow the research ethics. He took interview with childrens, mathematics teachers and head teachers. He observed the classroom until 30 days and he generated the data.

From the analysis and interpretation of data he concluded that students, teachers and parents play an important role for learning new knowledge. These are also provider of sound environment for improvement of pass rate. Teacher didn’t link between new mathematical concept and previous learning mathematics concept. Mathematics anxiety, negative feeling of mathematics, economic condition, their educational background were the main causes of difficulties. Also the school management system, infrastructure of school and lack of regular assessment system of school were main causes of difficulties in learning mathematics.

Similarly, I reviewed one international journal on the topic “Difficulties Encountered by Students in the Learning and Usage of Mathematical Terminology”.

This study sought to review literature pertinent to difficulties encountered by students in the learning and usage of mathematical terminology. The need to carry out this study arose from the concern by the Kenya National Examinations Council, and the general public, over the poor annual results in mathematics. Therefore, the objective of this study was to investigate the extent to which the meanings of some mathematical terms are understood and/or confused by students for whom English is a second language. The basis of this study was the constructivist theory by J. Bruner and the cognitive flexibility theory of R. Spiro, P. Heltovitch and R. Coulson which advocates for teaching learners to construct the meanings of mathematical terms.

This study's objectives were achieved through the use of document analysis. Data analysis involved document review. The findings of this study showed that students have difficulties in using mathematical terms and their related concepts. Possible ways of teaching these terms so as to generate more meaning to the learners were also suggested. It is hoped that this will assist mathematics teachers, curriculum planners and textbook authors to counter the poor performance in the subject in Kenya.

Kenney (2008) studies on "Influence of symbols on pre-calculus students problem solving goals and activities". The objectives of this study were to investigate students uses and interpretation of mathematics symbols and the influence that symbol have on students goals and activities when solving test with and without graphing calculator .Six samples were selected from college students and qualitative (case study) design used. The finding of this study that symbols and symbolic structure had strong influence on students' choices in problem solving. Graphing

calculators used as a way to abandon symbolic manipulation, although few connections were made between symbolic and graphic numerical form.

Bhandari (2017), conducted the master's degree thesis on the topic "difficulties in learning group theory". The main objectives of the study were to explore student's difficulties in learning group theory at grade XII and to analyze the causes of difficulties in learning group theory. The design of the study is qualitative case study and five students were selected by purposive sampling method from a school as respondents for interview and test and their respected teacher.

As well as a set of question was constructed of five different domain on the basis of Blooms taxonomy of educational objectives. The result from the test administration and interview of the respondents' information was analyzed and strengthened with the help of related literature. The collected data from the primary sources such as test interview and discussion were analyzed by using different theories described method.

He found that difficulties in learning group theory are misconception of group theory, difficult to link new concept, difficult to remember mathematical terminology for long time .More teachers are dependent in the subject matter of the text book and lack of resources related to group theory are main cause. Lack of individual attention is another problem.

Moreover, Thapa (2016), studied on "Learning Difficulties in Trigonometry" in Bardiya district. The objectives of this study were to find the causes of difficulty in learning trigonometry at secondary level and to minimize the learning problems in trigonometry at secondary level. The design of this study was survey with five institutional and five community schools. Sample of the study were 200. Interview

guideline, observation form and questionnaire were the tool of this study. He observed the classes of selected schools in twenty days. The researcher collected the data on the basis of the conceptual framework. Dimension of the conceptual framework were school environment, interaction, teaching method, materials, activities in classroom, evaluation techniques, and pre-knowledge.

He found that there were no sufficient materials and few intersections between teacher and students. So students feel difficult in learning trigonometry. Teacher had not clear concept about trigonometry so it created more confusion and learning difficulties in trigonometry. Teacher used lecture method thus students were passive and lazy in classroom. Teacher had not implemented the modern techniques, methods and materials for trigonometry teaching and learning. So students took trigonometry as an abstract chapter.

From the above all reviews I concluded that difficulties of students for learning mathematics depend on the home environment, economical condition of parents, school environment, peer group, pre knowledge about subject matter. Teaching method and materials, language, class participation and regularity are the main factors those affect the learning mathematics. Moreover lack of thinking power, lack of text book and materials, teachers did not check homework and classwork properly are the affecting factors of learning difficulties. Intersection and evaluation system are also the affecting factors of learning difficulties.

Thapa completed the research on the topic “Learning Difficulties in Trigonometry” but I completed the researcher study on the topic “Learning Difficulties of Students in Trigonometry”. His research objectives were to find the causes of difficulties in learning trigonometry at secondary level and to minimize the

learning problems in trigonometry in secondary level. My research objectives were to find out the difficulties of students in learning trigonometry at grade X and to explore the remedies of difficulties of students in learning trigonometry at grade X. I used achievement test but he used questionnaire for research tool.

He used survey research design in Bardiya district but I used mixed method research design in kirtipur municipality for research. School environment, interaction, teaching method and materials, pre-knowledge and activities in classroom were the dimension of his conceptual framework. Theorem deduction, understanding, application, remembering, simplification and transition the verbal problem in to figure were the dimensions of my conceptual framework.

He found that there were no sufficient materials and few intersections between teacher and students. Teacher had not clear concept about trigonometry. Teacher used lecture method thus students were passive and lazy in classroom. Teacher had not implemented the modern techniques, methods and materials for trigonometry teaching and learning so students took trigonometry as an abstract chapter.

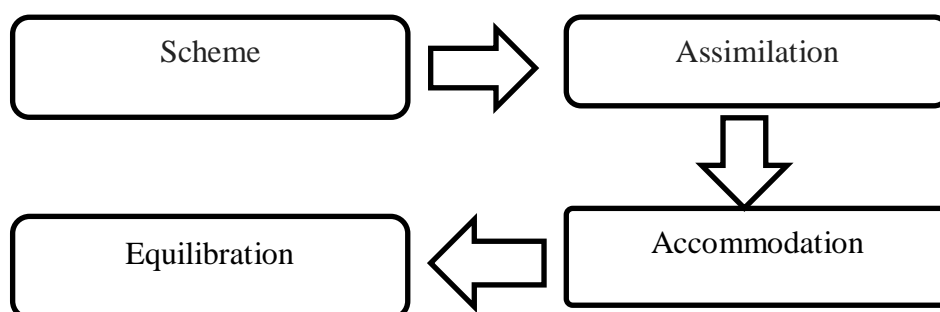
I found that students want to rote learning more than meaningful, they want exam oriented questions because to get high mark in exam without conceptual learning. The students of the government schools get opportunity to read optional mathematics only from grade IX thus basic concept shows poor then students of private school. Mean score of obtained mark of achievement test obtained by students of government school was less than private school but standard deviation was more. Some of the students they know formula but they don't know the appropriate use of those. Main thing of the difficulty of students was negative attitude towards

trigonometry. Students solve the questions haphazardly unless they forget to read the total question. Thus my researcher work is different from the research work of Thapa.

Review of Theoretical Literature

Any kind of research had developed by the any theoretical base. Theories are formulated to explain, predict, and understand the phenomena in any cases. The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory that explains why the research problem exists under study. The theoretical framework connects the researcher to existing knowledge. A theoretical framework specifies key variables which influence a phenomenon of interest and highlights the need to examine how those key variables might differ and under what circumstances.

Piaget's constructivist learning theory. Piaget's theory of constructivism argues that people produce knowledge and form meaning based upon their experiences. Piaget's theory covers learning theories, teaching methods and education reform. Four key components which create an individual's new knowledge these are scheme, assimilation, accommodation and equilibration. How students develop the mind or create knowledge about anything these are depends on the four key components. Process of constructing new knowledge has shown as below:



Scheme. Before start the work student makes an image or plan in mind about the work it is called scheme. Each and every person makes that kind of plan before start the any work. Schema may or mayn't be match in real problem. It is a mental figure to do new work as well as it is related to personal ideas for enters the new situation. Piaget defined a schema as: "A cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning."

Assimilation.In the real situation, the schema matches with the problem it is called assimilation. Any people make an idea before solving the problem, those ideas use at first for solving the problem. If the scheme matches in new situation then people finalize the knowledge.

Accommodation.If the schema doesn't match the new situation then people correction the schema according to new situation this process is called accommodation. When schema can't work then people search for new ideas. This happens when the existing schema (knowledge) does not work, and needs to be changed to deal with a new object or situation.

Equilibration.Equilibration involves the assimilation of information to fit with an individual's own existing mental schemas and the accommodation of information by adapting it their way of thinking. It is the balancing of work between assimilation and accommodation.

Moreover, people learn the new content according to the process of schema, assimilation, accommodation and equilibration. In case if there is any disorder and misunderstanding in any point then people feel difficulties in this contains. For constructing the knowledge of people must follow the piaget's process of constructing

the knowledge. If the student does not have any schema then he/she can't understand the problem as well as further solving process.

In constructivist approach, students need to construct the knowledge from their own understanding and practice. Difficulties arise at that time when students can't make schema. If students made scheme but in real situation it doesn't match then students feel difficult related topics. If there is no any opportunity to involve in knowledge building program. Piaget proposed four stages of cognitive development.

Those reflect the increasing sophistication of children's thought: Sensorimotor stage is birth to 2 years and Pre-operational stage is 2 to 7 years. Moreover, Concrete operational stage is 7 to 11 years and formal operational stage is 11 to adolescence. The formal operational stage begins at approximately age eleven and lasts into adulthood. During this time, people develop the ability to think about abstract concepts, and logically test hypotheses. This shows that difficulties of students in learning depend on the age too. Age directly affects the students for understanding, interaction and translation the problem.

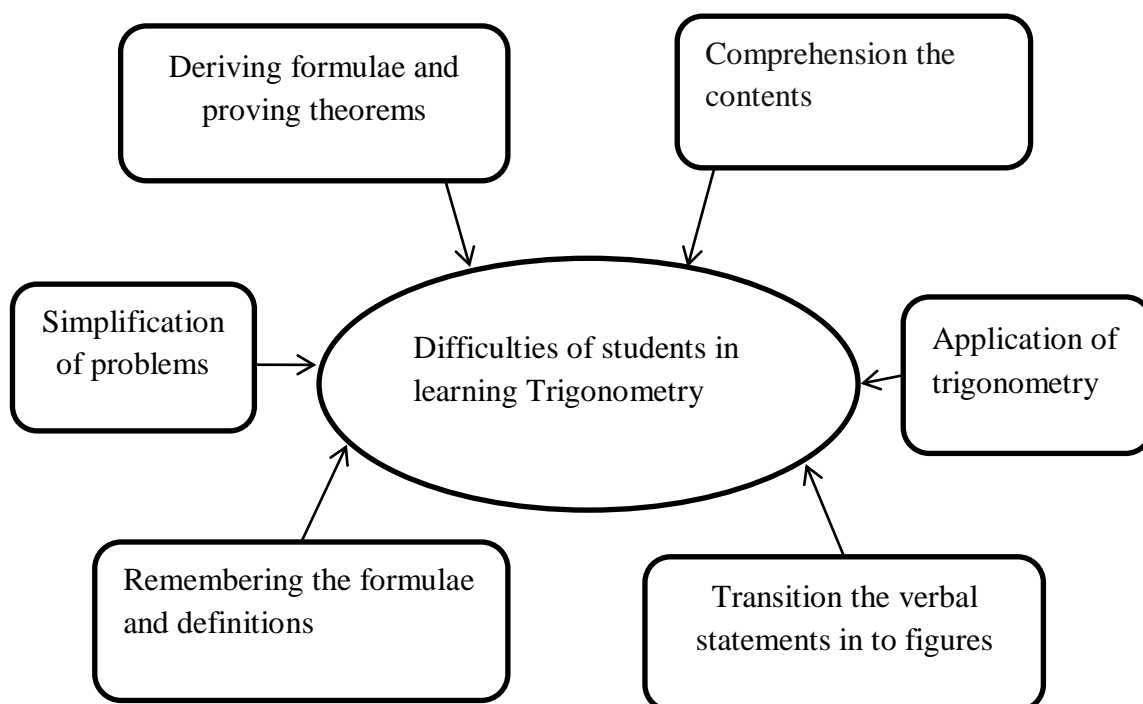
Scheme is a mental figure to do new work as well as it is related to personal ideas for entering the new situation. If scheme matches the new situation it is assimilation if doesn't match in real situation that is difficulty for students. Students try to solve the problem but not sure they can solve or not this shows that it is difficulties for students. I used same theme in my research. So piaget's constructivist learning theory is applicable for my research.

Conceptual Framework

A conceptual framework is an analytical tool with several variations and contexts. It can be applied in different categories of work where an overall picture is

needed. A conceptual framework is a bit like a blueprint. It provides an outline of how researcher makes plan to conduct the research. Writing a conceptual framework can not only help to guide the thesis to ensure that research stays on track. It plays an important role in guiding the entire process of the research study.

I reviewed some masters' thesis among them different person found different difficulties of students in learning mathematics. Ghimire (2013) found that low participation in class room and Gautam (2017) found that school environment is not suitable. Yadab (2017) found that lack of pre-knowledge, Acharya (2017) found that lack of regular assessment and mathematics anxiety and Bhatta (2017) found that that lack of reference book and project work. Bhat (2017) found that teacher didn't use student center method those were the problems or difficulties of student in learning mathematics. So in my view conceptual framework refer to the mental picture of any study. It deals about the concept of possible areas of the study. These difficulties found already. So that I have made a conceptual framework which is as follow:



The above conceptual framework shows that there are six main dimensions of difficulties of students in learning trigonometry. Short description of above components of framework is given below:

Comprehension the contents. Comprehension is a psychological process related to an abstract or physical object, such as a person, situation, or message where by one is able to think about it. Comprehension is related to the knower and an object of understanding. Comprehension implies abilities and dispositions with respect to an object of knowledge that are sufficient to support intelligent behavior. In trigonometry, if students going to solve the trigonometric equation, prove the trigonometry identity, solve the 'height and distance' world problem then students first need to be understand the word problem and trigonometry content. When student understand the given problem then student becomes clear about what is known and what is unknown as well as what to find? So comprehension the problem is main dimension.

Simplification of problem. Simplification is the act or process of making something simpler. In trigonometry, there are some trigonometry ratios those are abstract in nature. Students can't understand those ratios. In simplification the problem of trigonometry students need to create next step in mind before solving problems. We should be used formula and techniques for further steps of any problem. For simplification the problem students need to know knowledge about trigonometry ratios and operation of those ratios.

Application of trigonometry. Application is solving problems in new situations by applying acquired knowledge, facts, techniques and rules. Learners should be able to use prior knowledge to solve problems, identify connections and

relationships and how they apply in new situations. In my study application means when the students learn the formula or some techniques of any content then students use this formula and techniques in similar problem in different situation.

Students learn some formulae at the starting point of the trigonometry and if students can apply these formula in next condition it is perfect application .If students can't use in different condition it is difficulties related to application. If students can use given condition in further solving process it is called the application. In trigonometry application is most importance part of solving the problem.

Transition the verbal statements in to figures. In trigonometry there is a sub-topic “Height and Distance”, In this topic almost problems given in verbal. For solving those problem students need to know transition process and concept of angle of elevation as well as angle of depression. If students can make figure according to given question then they can solve the problem otherwise may not be solve. Thus, transition the verbal statement in to figure is one of difficulty of students in learning trigonometry.

Deriving formulae and proving theorems. In mathematics, a theorem is a statement that has been proven on the basis of previously established statements. Other statement, theorem, axioms can be use to prove the new theorem. A theorem is a logical consequence of the axioms. In the trigonometry formula deduction work is really challenging work. To deduction the theorem students need content knowledge, skill and some combination of previous proved statements as well as some figures too. It is the first process before solving the problems. Students have so many difficulties in deduction the theorem.

Remembering the formulae and definitions. Knowledge involves recognizing or remembering facts, terms, basic concepts, or answers without necessarily understanding what they mean. In mathematics most of the content need to be remembers like formulae as well as definitions. According to bloom taxonomy knowledge level is the first level of cognitive domain.

Why the students can't remember the formula? Why student can't list the definition? To get the answer of this question I put this dimension in conceptual framework. Students can or can't state the formulae and definition same to same without seeing that was main objective of dimension of conceptual framework.

Chapter III

Methods and Procedures

Research method presents the process of study because it determines how the research becomes complete and systematic. Educational research can be divided in to three broad categories: quantitative, qualitative and mixed design. I used mixed method design for my research work. This chapter contains research design, population of study, sample of study, data collection tool, reliability and validity of the tools, data collection process and analysis process.

Research Design

I completed the research work on the topic “difficulties of students in learning trigonometry”. For this research I used mixed method research design. The first objective related to quantitative data and second objective related to qualitative data. There are three types of mixed method design those are parallel design, sequential design, embedded design (Creswell, J. W. 2008). I applied explanatory sequential design. The quantitative data came from the students’ achievement test and qualitative data came from the interview of students, teachers and mathematics experts. I analyzed and interpreted quantitative data at first and qualitative data. So it is mixed method design. Symbolically it is written as QUAN+qual.

Population of the Study

A research population generally refers to a large collection of individuals or objects which main focus is on a scientific query. The populations of this study were the students of grade ten of Kirtipur Municipality those were studying optional mathematics of the academic year 2075.

Sample of the Study

The sample should be representative of the population to ensure that we can generalize the findings from the research sample to the population as a whole. I took four schools from the Kirtipur Municipality. Among four schools two schools were public and two schools were private. The samples of my study were all the students of optional mathematics of those four schools. Total students of optional mathematics of those four schools were 155. Among them, there were 100 students from two private schools and 55 students from two public schools. Among 155 students I took 5 students for interview by using purposive sampling method those students obtained the low mark in achievement test. Among five students two students were from private school and three students from public school.

Furthermore, I took three mathematics teachers those were teaching optional mathematics in grade X of selected schools in Kirtipur Municipality. I took three mathematics experts From the Department of mathematics education of Tribhuvan University by the purposive sampling method for obtain the detail data. There are many types of purposive sampling methods I used convenient sampling method.

Research Tools

Anything that becomes a means of collecting information for the study is called a research tool. The main tools of the study were achievementtest and interview guidelines. The achievementtest made for students and interview guidelines made for students, teachers and experts. Short descriptions about these tools are as follow:

Achievement test. Achievement test is a kind of assessment which is special tool of measurement of knowledge of students. It is widely used to evaluate the

students formally. It helps to examine the knowledge of students on the particular subject matter (Bhattarai,2014).

I made one test paper for fulfillment the first objective. Achievement test was important tool in this study to collect the quantitative data. I prepared the test paper according to bloom taxonomy. Questions were simple to complex but all questions had taken from trigonometry part of the optional mathematics. Questions were from remembering level to creating level based on the bloom taxonomy.

Full mark and pass mark of the test were fifty and twenty respectively. The time of the test was one hour forty five minutes which is indicated by the help of pilot test. Some questions were related to formula writing and definition writing. Three questions were from height and distance among them one definition, one description the figure and last translation the verbal problem into the figure and then solve. Three questions were formula proving and two questions were related to simplify. All total eighteen questions were there, among them there were four questions for one mark, six questions for two marks, six questions for four mark and two questions for five marks. Questions set put in appendix –D.

Interview guidelines. Interview guideline is the supporter for the researcher. I used the guideline for obtaining the new and objective related data. I made three interview guidelines for the fulfillment of the second objective. I made the interview guideline by the help of conceptual framework. In interview guidelines were based on the possible areas of difficulties of students in learning trigonometry.

According to my conceptual framework there were six dimensions of difficulties of students in learning trigonometry. I asked the open questions with five students about difficulties of basic knowledge, simplification of problems and

theorem deduction. Similarly, some others headings were, transition the verbal statement in to figure, application, understanding and remembering.

Moreover, I asked the open questions with three mathematical teachers about students' difficulties and remedies of those difficulties. I took interview with the help of interview guideline on the basis of, theorem proving, application and transition the verbal statement in to figure. Moreover, understanding, simplification of various types of the trigonometric problems and remembering were also heading of the interview.

Similarly, for fulfillment the second objective I took interview with three mathematical experts on the basis of understanding, in application as well as simplification. Remembering, transition the verbal statement in to figure, formulae proving, linkage between different ideas and trigonometric theoretical concept were also headings of interview seating. These three interview guidelines of students, teachers and experts put in the appendix E, F and G respectively.

Reliability and Validity of the Tools

Reliability is the degree to which an assessment tool produces stable and consistent result (Bhattarai, 2014). I established the reliability of the tool (achievement test) by the split-half test method. The test questions were tested by six students for maintain the difficulties level, reliability of question and time for examination period before the final test. I took the test with six students and tabulated the total obtained mark in odd questions as well as even questions of each student. According to the table number one and two from the appendix-A, correlation coefficient of pilot test is 0.82. which is calculated by using formula (1) and (2) of appendix –C. According to garret, 2008 from table number 3 of appendix –A correlation value showed that the reliability of question is very high.

I established the validity of the tool by the help of thesis supervisor, optional mathematics teachers of the selected school and one mathematics expert. Researcher made the question according to the bloom taxonomy .Teacher, expert and supervisor corrected the test question then after I took exam with students. Validity of the qualitative data was maintained by triangulation method.

Data Collection Procedure

Data collection is a process of collecting information from all the relevant sources. For collect the data at first, I visited the selected four schools .Among four school there were two private schools and two public schools of kirtipur. Then I went to school administration and told about my purpose and I took the permission to take test with optional mathematics students of class ten.

After taking the permission I took test of optional mathematics students of class ten. Researcher took interview with five students in same school those students obtained the low mark in exam. I said with students about my student life and about the optional mathematics before start the interview in all schools. I asked with students why you selected the math in optional subject. After some conversations students felt easy with me for further answering. I took interview about ten minutes with each student. I told them what kinds of question I ask to you reply answer clearly and truly. It is only for my thesis proposal not for other purpose so provide the answer as possible as fact. I took the help of interview guideline for interview. Again I took interview with three teachers those were teaching optional mathematics in class ten. I did record the reply of the student's voice, teachers' voice of interview.

Similarly, Researcher had selected three mathematics experts by the purposive sampling method then I took the interview with them I wrote all the answers given by

experts. Researcher did record all the answers of all responded of the researcher's open questions. Difficulties of students in learning trigonometry obtained by the achievementtest as well as some oral data from student's interview and teacher's interview. For the second objective the remedies of difficulties of students in learning trigonometry at grade X was obtained by the interview of mathematics teachers and mathematics experts.

Data Analysis Procedure

Data analysis procedures are the process of systematically applying statistical data. I used mean and standard deviation for analysis the quantitative data taken from the achievementtest of students of grade X. I had analyzed the qualitative data taken from the interview of students, mathematics teachers and mathematics expert by the help of general inductive method described by Thomas (2006) and thematic approach.

General inductive method is process of finding conclusion of research. In this process researcher had put the data at first obtained from the responders. According to data researcher make the meaning and use the theory which is related to meaning of the data. Obtaining conclusion from the meaning of data and theory this process is called general inductive method described by Thomas. Moreover, collected data through achievementtest and interviews were analyzed and interpreted on the basis of the frame work developed in review of literature section.

Chapter IV

Analysis of Data and Interpretation of Results

This research ‘difficulties of students in learning trigonometry’ related to grade X of Kirtipur municipality. This chapter deals with the analysis and interpretation of collected data. This chapter is the main body of the research. This is the explanatory sequential research of mixed method design. The objectives of the research were ‘to find out the difficulties of students in learning trigonometry at grade X’ and ‘to explore the remedies of the difficulties of students in learning trigonometry at grade X’. To fulfill those two objectives I made two research questions.

There were 155 students for sample of this research. I used achievement test and interview guideline as tools for conducting this research study. For fulfillment of the first objectives I used the achievement test with selected all students as well as I took interview with five students who obtained the low mark. In achievement test I made question according to Bloom Taxonomy. All the questions had taken from the trigonometry chapter. For fulfillment of the second objective Interview had taken with three mathematics teachers those were teaching optional mathematics in selected schools at secondary level and three mathematics experts from Department of Mathematics Education of Tribhuvan University.

Again for fulfillment of the first objective I had collected the some oral data from students and teachers by the help of interview schedule. I selected those students who obtained the least mark in examination. Among them I had selected three students from government school and two students from private school. I selected those teachers who were teaching optional mathematics at grade X. I asked questions which

were related to difficulties of students in learning trigonometry in different topics but most of the responses of them were same. I collected the oral data from students and teacher by the help of interview guideline. I put the interview guideline of students in appendix –E and appendix-F. Then by triangulation method researcher analyzed and interpreted the obtained verbal data under the following headings:

- Difficulties in remembering the trigonometry formulae and definitions
- Difficulties incomprehension of the trigonometry content
- Difficulties in deriving formulae and proving theorem of trigonometry
- Difficulties in simplification of trigonometry problems
- Difficulties in application of trigonometry problems
- Difficulties in transition the verbal statement in to figure of height and distance

Mean and Standard Deviation of Achievement

Main sources of the information of this study were students of class X from secondary level of two public and two private schools. Mean and standard deviation of the obtained marks of 155 students from achievement test has shown in the table below:

Types of School	Number of Students	Mean score of obtained mark	Standard Deviation of obtained mark
Government	55	17.55	12.83
Private	100	23.2	10.62
Government+ Private	155	21.19	11.76

From the above mentioned data of the table had taken from the appendix-B. It is conclusion of appendix-B. Comparatively, from the above table government school's mean mark of obtained mark is less than the private school. This shows that difficulties of students in learning trigonometry of government school more than private school. Standard deviation of obtained mark of private school is less than government school. This shows that obtained marks of students is less spread out from mean value of private school and more spread out of government school. Meanscore of the obtained mark was 21.19. Students' achievement of trigonometry shows very weak. The fullmarks of the achievement test was fifty and pass marks was twenty but in average mark of obtained of student was 21.19 this shows that students have problem in trigonometry.

Standard deviation is used to tell how measurements of a group are spread out from the average value. A low standard deviation means that most of the numbers are very close to the average. Standard deviation of obtained mark of students from government school is more than private school. This shows that obtained marks of students of government school were more spread out from the mean score. Obtained mark of students from private school is less spread out than government school.

Data shows that some students of government school are very weak. Standard deviation of obtained mark of students from private school is less than from government school. It is clear that achievement of students of private schools better than students of government schools. In conclusion, average score was 21.19 of 155 students. It is poor score thus students has difficulties in learning trigonometry.

Difficulties in Remembering the Trigonometry Formulae and Definitions

I made achievement test according to Bloom's Taxonomy. Among six levels of

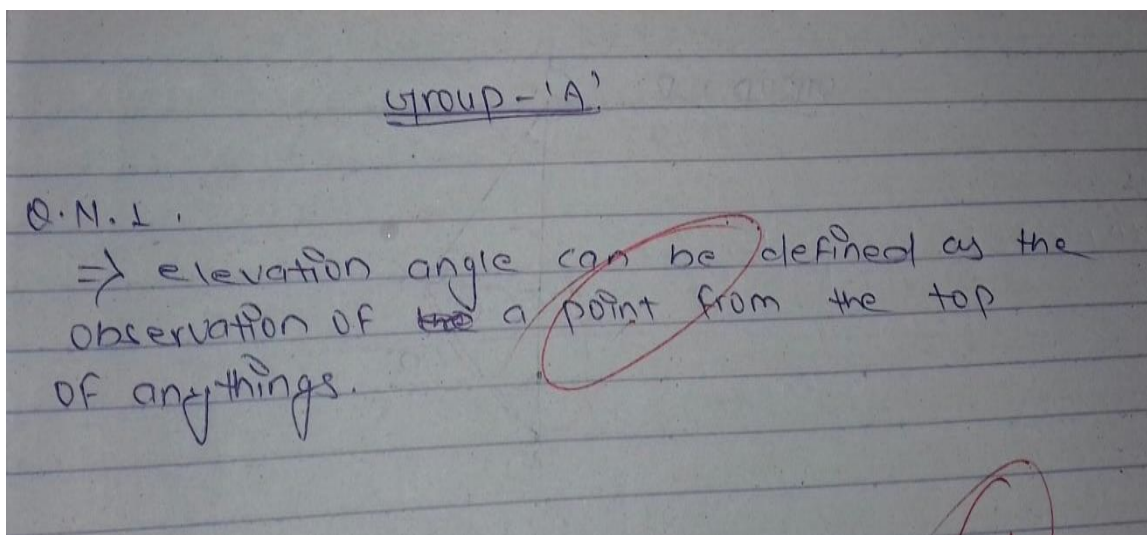
bloom's taxonomy remembering level is the lowest level. The first level is retrieving, recognizing, and recalling information. It provides the base for all "higher" cognitive activity. Among 18 question of achievement test three questions were remembering level. Three questions were define the elevation angle, list the formula of $\cos 2X$ in terms of $\sin X$ and $\tan X$ and formula of $\cot(A+B)$, $\cos(A+B)$. When I checked the answer sheet then saw many mistakes even formula. Students wrote the formula but almost sign were wrong. Correct answers of those questions should be: Formula of $\cos 2X$ in terms of $\sin X$ and $\tan X$ are as bellow: $\cos 2X = 1 - 2\sin^2 X$ and

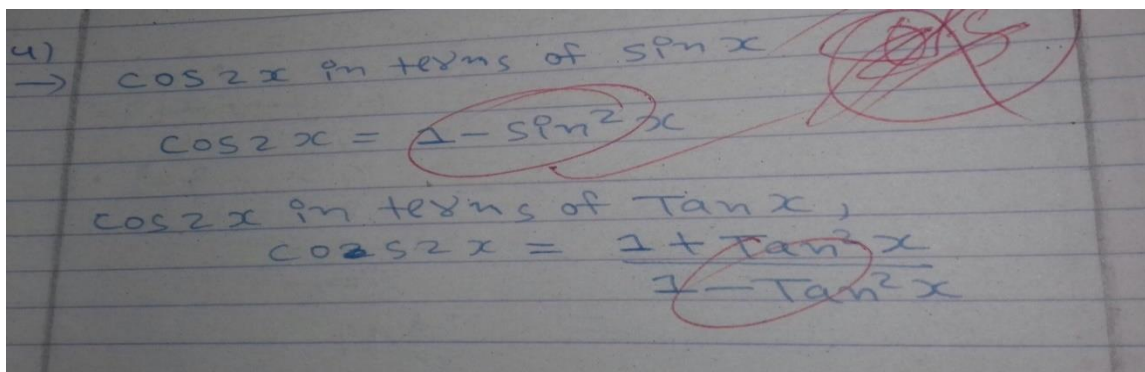
$$\cos X = \frac{1 - \tan^2 X}{1 + \tan^2 X} \cos(A+B) = \cos A \cos B - \sin A \sin B \text{ and } \cot(A+B)$$

$$= \frac{\cot B \cot A - 1}{\cot B + \cot A}$$

Definition of elevation angle: When we look at on object above the horizontal line, the angle so formed between the horizontal line and the imaginary line of sight is called angle of elevation.

I checked the answer sheet of students. I got mistake in definition and mathematical sign. Some examples of student's mistakes in exam have given below:





From the above two answers given by two students' shows that student wrote definition his own understanding. Students didn't care the voice of teachers and correct definition of book. They did mistake in sign and left the terms too. To compare these two answers with above mentioned correct answer. In above answer written by student $\cos 2x = 1 - \sin^2 x$, student left 2 before $\sin^2 x$. There is lack of sign remembering. Some students they wrote mistake in answers sheet and some students they left the question. Researcher took interview with them. Students' and teacher's voices of these problems are as below:

"We can't remember mathematical terminology for long time" (Student 1)

"We have lack of individual attention and teacher focus to student" (Student 2)

They told we can't remember the formula as long time because we have short time for practice formula. Some of the schools there are so many students in a one class thus it is difficult to handle for teacher. Teacher can't check one by one their practice copy in class room. Some students they copy only from the board written by teacher. In same case another student and teacher told about remembering those voices are:

"Students they use own their understanding in exam they didn't care teachers' voice and they had misconception about trigonometry." (Teacher 2)

“In trigonometry there are so many formulae after completion all formula we feel confuse where is ‘+’ where is ‘-’. If we write plus instate of minus formula 100% wrong small error shows that big mistake.” (Student 5)

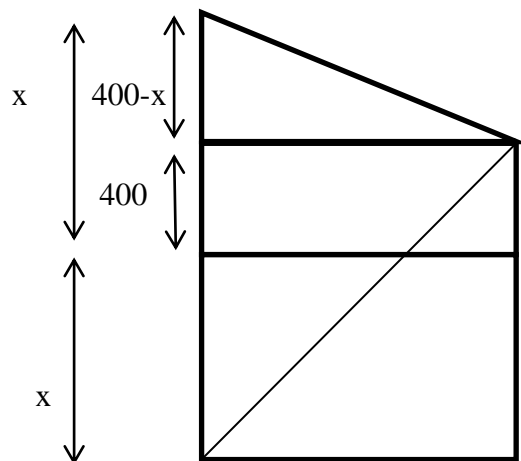
Trigonometry chapter has so many formulae if any sign mistake then result 100 % wrong. We solve the any problem by seeing the formula list in same time. We solve or practice any questions together with formula list. Maximum one month takes the time for teaching trigonometry. Final exam of class ten be in last month of the year five months gap between teaching time and exam time so we can't remember the formula as well as definition for long time.

From aforementioned solution of students' problem while learning formula response of students and responses of teacher difficulties of students in learning trigonometry matched with difficulties in learning group theory (Bhandari, 2017). Thus students had low collection of mathematics terminology. Lack of individual attention and they used their own words in exam and didn't care teachers' voice. They had problem in sign and misconception of trigonometry. There is maximum gap between teaching time of class and exam's time so students can't remember long time.

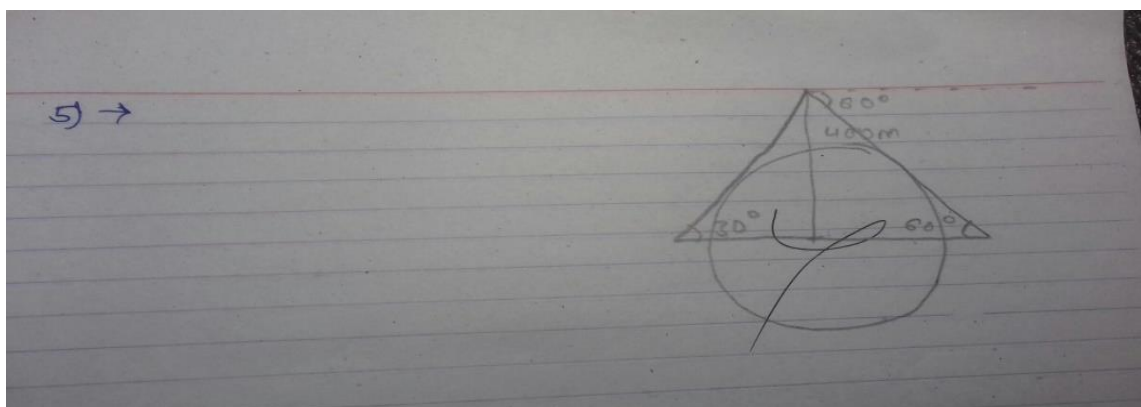
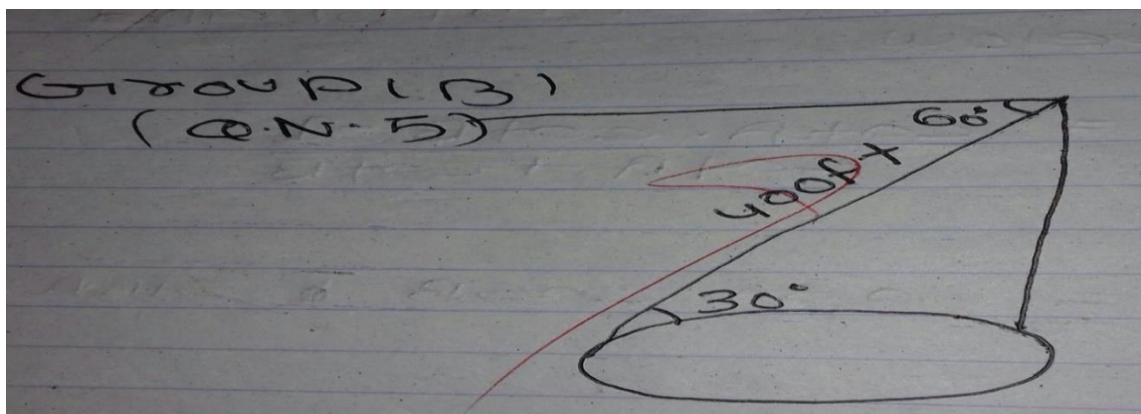
Difficulties in Comprehension of the Trigonometry Content

Understanding difficulties means those difficulties students are unable to comprehend the trigonometry concept. Understand the involving the range of different skills. It is the second level of Bloom Taxonomy. In each and every question students must understand what is given and what to be do. Students had difficulties in words, concepts, abstract statement and memory. Some student told that, they didn't pay attention in class while teaching time. Question was 'the angle of elevation of a

bird from the point 400 feet above a pond is 30° and the angle of depression on its image in the pond is found to be 60° . Draw the figure only according to above information'. Students did mistake but correct answer of that question is



I put the some answers and voices of the students and teachers. Solutions of question number five by students has shown as below.



From the above solution shows that student did not understand the words of question. Student didn't know about elevation angle and depression angle, knowledge of reflection and skill of drawing figure. Student didn't write any given condition in the solution steps. This shows that understanding level of students' is very low. I took interview with students for the question, why it is difficult to understand the trigonometry concepts? The edited versions of respondents' are as follow:

“It is very hard to understand because most of the friends and also teacher said trigonometry is more difficult than other contents. Most of the contents are not useable in daily life. Almost content of trigonometry are abstract as well as some terminologies are new for us. In government school optional mathematics started from class nine so we hadn't strong base for optional mathematics.” (Student 1)

“Low quantity of trigonometry contain put in compulsory mathematics.” (Student 5)

From the above information of the student new knowledge is hard to understand by the voice of friends as well as teachers. In mathematics geometry's content and arithmetic's contents are useable in daily life but almost content of trigonometry not useable in daily life. Trigonometry course is started only from class nine. In lower classes there is no trigonometry and curriculum refer low quantity of trigonometry in compulsory mathematics. Almost course of trigonometry are abstract and some content very new for students. So that students felt difficulties to understand the trigonometry content.

The researcher asked the question with mathematics teachers “Why is it difficult to understand the concept of group theory?” How does understanding affect learning trigonometric concept?

“For comprehend the trigonometry it requires pre-requisite knowledge and concept. But the students in the classroom lack of those understanding. They have problem with understanding the simple concept of elevation angle, depression angle, reflection of object, reciprocal of trigonometry ratios, sub-multiple angle and so on. These are the main problems for not understanding the new concept of trigonometry.”

(Teacher2)

“It is necessary to understand the basic concepts, ideas and their application of any content. Any students must have good attitude towards subject matters of teaching.”

(Teacher 1)

I found that some of the students felt difficult to learn and remember new words such as elevation angle, depression angle and compound angle etc. They didn't understand the teacher's voice due to the various reasons such as: Different caste, language, terminology etc. All trigonometric ratios are abstract itself. Memorizing trigonometry concept without comprehension is another problem of understanding.

In formal operational period cognition reaches its final stage. By this stage person no longer requires concrete object to make rational judgments. He /she is capable of deductive reasoning. During this time, people develop the ability to think about abstract concepts, and logically **test hypotheses**. This shows that difficulties of students in learning depend on the age too. Age of student directly affects the understanding level of students. His /her ability for abstract thinking is very similar to an adult (Piaget, 1952).

From the above mathematics teacher's view lack of pre-requisite for learning trigonometry is the main problem of understanding. Effective understanding occurs only if new concepts are linked with previous concepts and good attitude of students

toward subject matters. The claim derived from the literature; with in the Piaget's constructivist learning theory. Students make schema before start any work by thinking how can I solve it easily. They use their scheme if it matches on the real problem they can learn it but if it doesn't work students feel difficult from this section.

They start to memorize what we learnt definition from the book without having proper understanding. Surface knowledge of abstract concepts develops misunderstanding in students. Obviously, this becomes difficult to learn. Difficulties level of ideas and concepts also increase when level of education increase. So due to the lack of knowledge and understanding of concept they are unable to grasp complex concept. Thus understanding difficulties is one of the prominent difficulties in learning trigonometry.

Difficulties in Deriving Formulae and Proving Theorem of Trigonometry

Mathematical proof takes the rule of logical deduction. Formula deduction is a logical operation of building the new formula by using definitions, axiom, some logical statement and valid theorems too. This involves well ordering principles, direct proving, indirect proving and giving counter examples. I put the questions related to formula proving to find out the students have difficulties or not. Most of the students of secondary level have difficulties in proving abstract concepts like formula and theorems. Correct answer of this question is as bellow:

$$a. \sin C + \sin D = 2 \sin \frac{C+D}{2} \cos \frac{C-D}{2} \quad b. \cos C + \cos D = 2 \cos \frac{C+D}{2} \cos \frac{C-D}{2}$$

$$\sin(A+B) + \sin(A-B) = 2 \sin A \cos B \text{ ----- (I)}$$

$$\cos(A+B) + \cos(A-B) = 2\cos A \cos B \text{ ----- (II)}$$

Suppose $(A+B) = C$ and $(A-B) = D$

Adding I and II result be $A = (C+D)/2$ and subtract (II) from (I) $B = (C-D)/2$

Now put the value of $A = (C+D)/2$ and $B = (C-D)/2$ in the equation (I) and (II) result

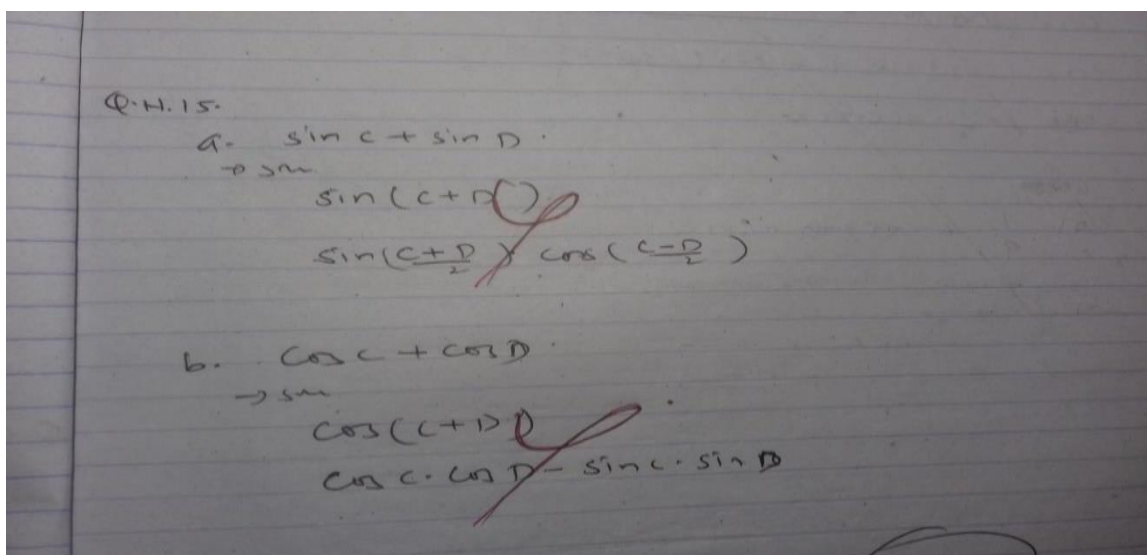
$$\sin(A+B) + \sin(A-B) = 2\sin A \cos B$$

$$\sin C + \sin D = 2\sin \frac{C+D}{2} \cos \frac{C-D}{2} \text{ It is required formula.}$$

$$\cos(A+B) + \cos(A-B) = 2\cos A \cos B$$

$$\cos C + \cos D = 2\cos \frac{C+D}{2} \cos \frac{C-D}{2} \text{ It is required result.}$$

In the examination I put some formulae for deduce but most of the students did mistake in proof. The result of the test of the students has shown below:



From above result it shows that student just wrote question and next step direct answer. There is lack of sequential proof, knowledge and use of other

mathematical terms. Students In conclusion student had never seen before that kind of problems. From the above student's solution he wrote $\cos C + \cos D = \cos(C+D)$ it shows that students has conceptual difficulty. Again in next step students wrote $\sin(C + D) = \sin(C+D)/2 \cos(C-D)/2$. It shows that student has difficulty related to remembering. Student lost to put 2 in coefficient. Thus I conclude that to prove the formula students must be able in remembering as well as concept clear in related content.

I took interview with some students of government schools as well as private schools and teachers too and their voices were as follow:

"It is very hard to prove such abstract formulae. We never practice to prove those types of formula. We just read the definitions, theorem statements and formulae statement only." (Student 4)

"I know to prove other numerical problems from the book but these types of formulae I haven't done before. We have to use formulae to prove other questions but obviously formula comes." (Student 1)

From above voices of students formula for problem solving but formula comes obvious. Student practice numerical questions only they never practice formula. Some of the students they know the definition and other formulae but they can't manage properly. Normally formula proof start from the class nine so had low experience in theoretical proof. Some of the formula of trigonometry can derive by the help of the figure. Some formula need to be proof without figure then students can't remember all abstract terms and process for long term. In same topic one teacher and one student's voice has shown as below:

“We know, proof is difficult not only for students for teachers too. According to previous trend those kinds of formulae didn’t ask in final exam. Students have not done such mathematics proof before, they knew the concept but unable to organize.”

(Teacher3)

“I know some definitions, formulae, examples of the trigonometry but when I start to proof, I cannot organize those formulae and definition to prove new formula.”

(Student 5)

Teacher told that we look trend and we teach that kind of question if any question reputedly asked in exam. Student told “I know definition and formula but I can’t organize”. Those kinds of difficulties had shown in student’s behavior. To prove the theorem students must be able to make the chain of definition and more practice but lack of those conditions builds the difficulty.

According to (Yadav, 2074), He found that lack of pre-knowledge and lack of practice are the main causes of difficulties of students in proving theorem. From the above views of three different students and teacher, I saw main problems of students’ were unable to organize the gained formulae, definitions, concept and knowledge. Almost steps of formula proof are verbal and abstract in trigonometry thus students feel difficult in learning. Formulas have no figure for proof like geometry. Students never practice before and formula is obvious no need to further proof.

Difficulties in Simplification of Trigonometry Problems

Simplification of problem is a mathematics process along with logic, reasoning and organizing the formulae. Most of the problems of trigonometry related to problem solving. Unless students are able to solve the problem, they cannot generalize. I made set of question from the simplification domain and given to the

students. Few of them tried to answers of those questions but solution were incorrect.

That means they do not have clear ideas how to solve abstract problems. Correct

answer should be as:

$$\begin{aligned} \text{Simplify: } & \frac{\sin^2 A - \sin^2 B}{\sin A \cos A - \sin B \cos B} \\ = & \frac{2 \sin^2 A - 2 \sin^2 B}{2 \sin A \cos A - 2 \sin B \cos B} && (\text{Multiplying numerator and denominator by 2}) \\ = & \frac{1 - \cos 2A - 1 + \cos 2B}{2 \sin A \cos A - 2 \sin B \cos B} && (\cos 2A = 1 - 2 \sin^2 A) \\ = & \frac{\cos 2B - \cos 2A}{\sin 2A - \sin 2B} \\ = & \frac{2 \sin (A+B) \sin (A-B)}{2 \cos (A+B) \sin (A-B)} \\ = & \frac{2 \sin (A+B) \sin (A-B)}{2 \cos (A+B) \sin (A-B)} \\ = & \tan (A+B) \end{aligned}$$

Two examples done by students has presented below:

14) $\sin^4 \frac{\pi}{8} + \sin^4 \frac{3\pi}{8} + \sin^4 \frac{5\pi}{8} + \sin^4 \frac{7\pi}{8} = \frac{3}{2}$

$= \frac{\sin^4 \frac{\pi}{8} + \sin^4 \frac{5-2\pi}{8} + \sin^4 \frac{8-3}{8} + \sin^4 \frac{5-2\pi}{8}}{2} = \frac{3}{2}$

$\frac{\sin^4 \frac{\pi}{8} + \sin^4 \frac{5\pi}{8} + \sin^4 \frac{8}{8} + \sin^4 \frac{5}{8}}{2} = \frac{3}{2}$

R.H.S proved,,

Q. no. 13

$$\frac{\sin^2 A - \sin^2 B}{\sin A \cdot \cos A - \sin B \cdot \cos B} = \tan(A+B)$$

$(\sin A - \sin B)(\sin A + \sin B)$
 $\sin A \cdot \cos A - \sin B \cdot \cos B$

L.H.S. = $\frac{\sin^2 A - \sin^2 B}{\sin A \cdot \cos A - \sin B \cdot \cos B}$

$$= \frac{2 \sin A \cdot \cos A - 2 \sin B \cdot \cos B}{\sin A \cdot \cos A - \sin B \cdot \cos B}$$

$$= \frac{2 (\sin A \cdot \cos A - \sin B \cdot \cos B)}{\sin A \cdot \cos A - \sin B \cdot \cos B}$$

$$= \frac{2 \sin A \cdot \cos A - \sin B \cdot \cos B}{\sin A \cdot \cos A - \sin B \cdot \cos B}$$

From the above two solutions of problems as well as some students voices they don't have good knowledge about how to break the whole fraction in to proper part. They are not familiar with mathematical abstract terms. They know some formula but don't know appropriate use. Students give only short time for simplification of problem. They can't find its answer or need to be doing more steps that is one main problem.

In simplification of problems students need logic of mathematical operation as well as some ideas. Some of the students have their family problem thus they need to do work at home at the time of study. Main problem is students love rote learning rather than meaningful in case of problem solving too. I took interview with students as well as teacher and responses of them are listed:

"I can simplify some problems of book but I feel confusion it is answer or some steps need to do to get answer. In school there is no regular assessment system so I don't have interest for mathematics practice." (Student 2)

“I have tried several times but could not. I think I had not clear concept about simplification. I didn't give more time if I confused in any problem. I have to do many works at my house so I didn't get time for practice. I start to do mathematics practice then feeling anxiety with maths. Thus I felt every question difficult for me.”

(Student 3)

I concluded that students voices shows that if they felt confuse then they left the further more process. Evaluation systems play the main role to decrease the difficulties of students. Students write some solution steps of question but that is final or need to be doing more that is main problem. Result shows that Student they leave the practice work for mathematics when they feel confuse. Some students they can't give more time for practice because of their house's work. In short time they want to prepare but it is hard work. It is impossible to achieve all the content knowledge in short time. In same heading teacher's voices are listed as below:

“They know the formula of compound angle thus they can simplify the problem related to compound angle but they feel confuse in multiple and sub-multiple angles. Main problem is students love rote learning rather than meaningful learning.”

(Teacher 3)

“Most of the students are excellent in simplification of the problem related to geometry, matrix and algebra too. They do practice only short time and if they feel confuse escape it. Sometimes they copy from the guide book. Such types of questions are not asked in previous examination.”

(Teacher 1)

I concluded that from the above responses of teachers student can simplify the question related to compound but they can't build the new formula in different nature.

Thus students want rote learning. Main problem is when students felt confuse they escape it'. Cheating system is more dangerous in learning area.

According to (Acharya ,2017)and from the above answer sheet as well as students' and teacher's voicethey never practice deeply of more questions if they practice they are very less. Students have mathematics anxietyif they practice some questions but can't find final answer then they leave on the way of solution. Some of the teachers teach model types questions only according to exam point of view. In case of abstract mathematics emphasis should not be given only model questions. Students don't want to think anything by multiple approach they love rote learning rather than meaningful.They do practice only short time and if they feel confusion to escape it and they copy from the guide book. Lack of regular assessment system in school they didn't not give more emphasis on practice mathematics at home.

Difficulties in Application of Trigonometry Problems

Application problems are the main body of the trigonometry. In this trigonometry problem in content takes the steps the formula of different nature.Students must be familiar to each and every formula of trigonometry for suitable use of formula.I found that one of the main problems of students is in application which formula can apply to get final answer of different problems. In achievementtest there were many questions related to application. From appendix-D question number seven and eight are related to application domain of bloom taxonomy.Correct answers should be as:

Prove that the following by using $\tan 60^\circ = \sqrt{3}$ and $\cos 60^\circ = \frac{1}{2}$

$$\text{or } \frac{1}{\sin 10^\circ} - \frac{\sqrt{3}}{\cos 10^\circ} = 4$$

$$\text{or } \frac{1}{\sin 10^\circ} - \frac{\tan 60}{\cos 10^\circ} = 4$$

$$\text{or } \frac{1}{\sin 10^\circ} - \frac{\sin 60}{\cos 60 \cos 10^\circ} = 4$$

$$\text{or } \frac{\cos 10 \cos 60 - \sin 10 \sin 60}{\sin 10^\circ \cos 10 \cos 60} = 4$$

$$\text{or } \frac{\cos(10 + 60)}{\sin 10^\circ \cdot \cos 10 \left(\frac{1}{2}\right)} = 4$$

$$\text{or } \frac{2 \cos 70}{\frac{1}{2} [2 \sin 10 \cos 10]} = 4$$

$$\text{or } \frac{4 \sin 101}{\sin 10} = 4 \quad \text{Hence, } 4 = 4$$

Among them solution of one question has shown below:

7.

$$\tan 60^\circ = \sqrt{3}$$

$$\Rightarrow \frac{1}{\sin 10^\circ} - \frac{\sqrt{3}}{\cos 10^\circ} = 4$$

$$= \frac{\cos 10^\circ - \sqrt{3} \sin 10^\circ}{\sin 10^\circ \cos 10^\circ}$$

\Rightarrow Dividing 2 on both numerator and denominator

$$= \frac{\cos 10^\circ - \sqrt{3} \sin 10^\circ}{\sin 10^\circ \cos 10^\circ}$$

$$= \frac{\frac{1}{2} \cos 10^\circ - \frac{\sqrt{3}}{2} \sin 10^\circ}{\frac{\sin 10^\circ \cos 10^\circ}{2}}$$

$$= \frac{\sin 30^\circ \cos 10^\circ - \cos 30^\circ \sin 10^\circ}{\frac{\sin 10^\circ \cos 10^\circ}{2}}$$

$$= \frac{\sin(30^\circ - 10^\circ)}{\frac{\sin 10^\circ \cos 10^\circ}{2}}$$

$$= \frac{\sin 20^\circ}{\frac{\sin 20^\circ}{4}}$$

$$= 4$$

R.H.S. = L.H.S.

use $\sqrt{3} = \tan 60^\circ$

Read the question before solve

From above solution of problem shows students gave answers of these question without understanding the question clearly. Students solve the questions haphazardly. Student didn't care the question. They solve according to their own knowledge and ideas. Students use that method only which used by teacher for solution the problems. Students had known some formula but they didn't know which is appropriate for correct solution. Some students did mistake in mathematical beside using correct formula. Students learn one method in classroom then always they use same method for solution of different problems. Lack of the time is main problem for

teaching the multi method of any problems. Some responses of responded are presented below:

“I know the formula and definition but I can’t decide which is applicable in this situation. There are so many formulae in trigonometry so I feel confusion which can I use to get right solution.” (Student3)

“I can solve the problems in examination which taught by teacher in the class room but I can’t write any steps if other conditions are given. I solve that question which method I learnt by teacher but in real that is not right. ”

(Students4)

Two or more than two formulae must be used in the question of trigonometry to reach in final solution. If student don’t know total formula then there is minimum chances to get the correct answer. Some students know the some formulae and definitions but they can’t decide which is applicable in this situation. Student must practice to choose the correct formula in different questions. Must of the student can solve the questions which done by teacher in classroom but they can’t solve further question because of lack of more practice. One teacher’s voice has given below:

“Some of the students they used their own ideas. They forgot the process which given by teacher. Students solve the questions haphazardly unless they forget to read the totalquestion.” (Teacher3)

Sometimes students solve the question without read the all given conditions. Students simplify the problem according to own their understanding but in real situation it may not be true. In examination times students have strong as well as more knowledge in contain matter because they preparedstronglymore than other

time. But some students feel hopeless when they see questions in question paper. They start to do haphazardly unless they forget to read the total question.

Difficulties to Transition the Verbal Statement in to Figure of Height and Distance

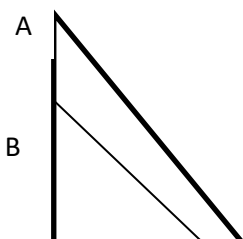
The trigonometry content cover the many sub topics among them ‘Height and Distance’ is one of the most importance as well as more useable topic. To solve the problems related to height and distance students must be know almost formula of trigonometry. Also students must know proper use of that formula because of it is the last part of this chapter. For solving the problem related to height and distance students must have knowledge of angles, deep understanding of question and skill of drawing.

Mathematical operations, formula of compound angle, multiple and sub-multiple angle are also play the main role for learning the trigonometry. If student can change the verbal question in to figure then students can solve that question. Solution of question depends on the figure construction according to given information. Some student’s voice and answer of question related question. From the appendix-D question no. five and seventeen related to transition the verbal problem to the figure.

From appendix –D question no 17: A vertical tower stands on a horizontal and is surmounted by a vertical flagstaff of height h . At a point on the ground the angle of elevation on the bottom of the flagstaff is α and that of the top of the flagstaff is β

then prove that the height of the tower is $\left[\frac{h \tan \alpha}{(\tan \beta - \tan \alpha)} \right]$

According to given information of question correct answer of that question should be,



From the above figure BC is a tower standing on a horizontal ground and AB is a flag standing on the top of the tower. D be any point on the ground. At a point (D) on the ground the angle of elevation on the bottom of the flagstaff is α and that of the top of the flagstaff is β . It means angle $ADC = \beta$ and angle $BDC = \alpha$. We have to show height of the tower is $[\frac{h \tan \alpha}{(\tan \beta - \tan \alpha)}]$. From the right angle triangle BCD

$$\text{or } \tan \alpha = \frac{BC}{CD} \quad \text{so,} \quad CD = \frac{BC}{\tan \alpha} \text{----- (I)}$$

Again, from the right angle triangle ACD,

$$\text{or } \tan \beta = \frac{AC}{CD} \quad \text{so,} \quad CD \tan \beta = AB + BC$$

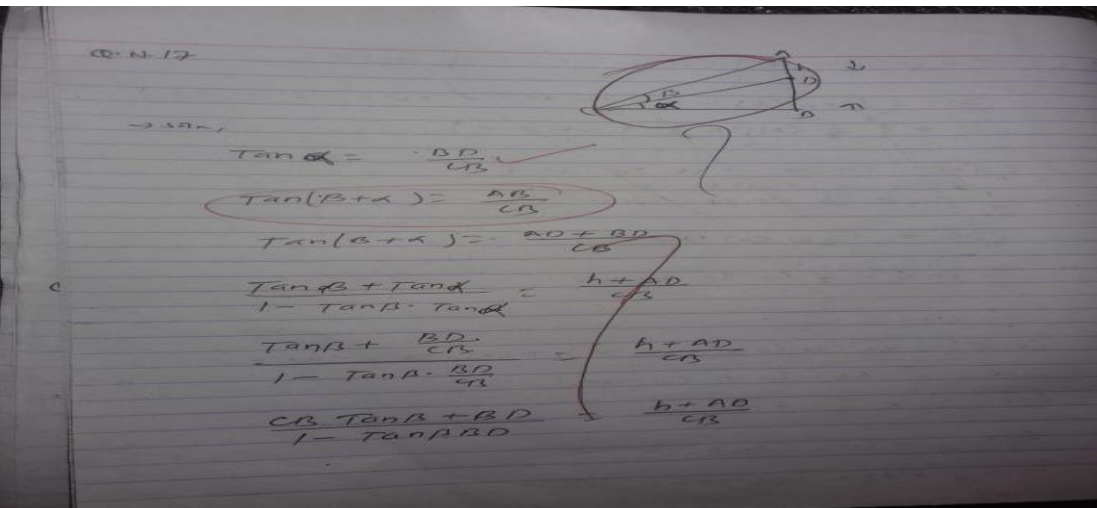
$$\text{or } AB + BC = \frac{BC}{\tan \alpha} \tan \beta \quad (\text{from I})$$

$$\text{or } AB \tan \alpha + BC \tan \alpha = BC \tan \beta$$

$$\text{or } h \tan \alpha = (\tan \beta - \tan \alpha) BC$$

$$BC = \frac{h \tan \alpha}{(\tan \beta - \tan \alpha)} \text{ which is required height of the tower.}$$

Student's answer has presented below:



From the above solution shows that students could not completed the solution. Student made the figure but he didn't the angle in proper place. When the student make wrong figure then solution of the question obviously goes wrong. To make the correct figure according to question students must be understand the concept of elevation and depression angle. Students must have the concept of geometrical figure too. I put the voice of responded together with this answer. I analyzed and interpreted the oral data and solution of questions given by students after the following voice:

"Sir, I know the definition of angle of elevation and depression. In the question paper I saw both angles in then I confused about the appropriate place of

angles.”

(Student 3)

“We did practice of these questions which done by teacher in classroom but we didn't practice parallel problem. Questions came in exam from out of book I did mistake.”

(Student 1)

From the above solution of problem by student and oral data taken from the interview main difficulty is lack of concept of angle. Student said “sir I know definition of elevation and depression angle.” But student can't substitute in appropriate place if both angles are given. Student they practiced only those questions which done by teacher in classroom. This shows that students had difficulties in transition the verbal problem in to figure.

“I didn't understanding the question because given elevation angles were α and β both abstract concept. Height of tower is $[h \tan \alpha / (\tan \beta - \tan \alpha)]$ it is not the numerical value so I didn't complete the solution.”

(Student 2)

“For solution of question no. five students need to know clear concept of angles, concept of reflection, concept of image and object. If student understand the question clearly then they can do but now a days student don't want to learn concept. When the grading system came in SEE then students became lazy.”(Teacher 3)

From the above students' voice and teachers' voice shows that most of the terminology of trigonometry content is abstract. Student feel easy when the angle given exact numerical value. For solution, transition and prove of any question basic knowledge and clear concept of content is fundamental needs. When the grading system came in SEE then students became lazy. Now a days student don't want to learn concept they want more mark in exam only.

According to (Bhat, 2017) students can't transition verbal problem into figure due to their basic concept. Basic concept means basic concept of triangle, angles, reflection of object. Students are exam oriented they want marks in exam without conceptual understanding. Student wants rote learning rather meaningful. Practice is the main thing in mathematics. Students don't want to practice of parallel question related to course book. According to (Kenney, 2008) Students can understand easily if angles given in numerical value but they feel hard angles given in abstract symbols. In height and distance figure must be correct to go further steps. When the grading system came in SEE students became lazy. Student read only from the exam point of view they think that how I can get high grade point, but they never think that how can I learn for better understanding.

According to Piaget's student make a plan for learning new knowledge. They make their own mental picture that called by scheme if it is match in real situation it is called assimilation. If do not match student feel confuse that is main difficulty of students. Students were not familiar to the abstract concept of trigonometry. When the grading system came in SEE then student left the hard practice in mathematics. Students can solve those questions which done by teacher already in classroom but parallel types question can't solve. Student focused on rote learning more than meaningful learning.

Remedies of Difficulties of Students in Learning Trigonometry

For the fulfillment of the second objective I took interview with teachers and mathematics experts. Second objective of the study was to explore the remedies of difficulties of students in learning trigonometry at grade X. I took interview by the help of interview guideline with three teachers those were teaching optional

mathematics in secondary level and mathematics experts. Most of their replies were same to each other. Appendix-F and appendix-G were the interview guideline of teachers and mathematics expert respectively. I told them all the difficulties of students in the interview time those difficulties found by the achievement test of students and interview with three teachers and five students. Oral data collected from teachers and mathematics experts are written as below:

“Students need to study formula and definition by making chain or pattern. If they study abstract concept by brazing with picture and local materials then they can remember long time.” (Expert A)

“For long term memory students need to repeat as possible as more. Studentsspend the maximum time at home. If they put the formula list and definition chart in their room’s wall then maximum time they see that written list it help to better remember.” (Expert B)

From the above two experts’ voice shown that remedies of difficulties related to remembering are students need to study definition and formulae by making chain and brazing with picture. A student spends maximum time at home if he/she put the list the formula and definitions then he /she see maximum time. It helps to long time remembering for any abstract content too.Rote learning contains only short time in mind. If student learn any content by making chain and connecting to other content they can remember long time. Reputation more and connecting with geometrical figures is the better ideas for long term memory.

“Students should be made mathematical vocabulary for clear comprehension of any content and students must be familiar with english as well as nepali languages.

Students should be developed the habit reading together with writing. Teacher should be tough pre-requisite knowledge before start the lesson” (Teacher 3)

Students can't learn if they don't have mathematical vocabulary. If student familiar in both English and nepali languages then student can comprehension in detail. Mathematics is special subject it need to be maximum practice for comprehend the content. If students re-check the solution then it helps to develop the knowledge. Teacher should be tough pre-requisite knowledge before start the lesson. Teacher should be tough pre-requisite knowledge before starts the lesson it help to student comprehend the content fast and easily.

Piaget (1952), student constructs the knowledge as well as comprehend the knowledge by processing of four steps. Those are scheme, assimilation, accommodation and equilibration. Thus according to four steps of Piaget's constructivist learning theory and above meaning obtained by oral data student can comprehend the content if student balancing of work between assimilation and accommodation.

“All students must have positive attitude toward subject matters then students can learn clearly. Students need to practice parallel problems and reputation habit must be grow up. If students practice maximum time then they can choose the suitable formulae for obtain the correct answer and they can comprehend and simplify the problems.” (Teacher 2)

“Students need to make clear concept in geometrical figures, mathematical terminologies as well as definitions it helps to derive the formulae and simplification the problems. Students totally eliminate the habit of negative thinking and anxiety. Student should be practice equally numerical problems and formulae”

(ExpertA)

Most of the students told trigonometry content is difficult so, for new content students already make the scheme it is hard chapter. All students must have good attitude toward subject matters. Teacher must be provided mathematical terminology as possible as much in related to contents. Students need to read questions carefully at the time of examination period. If any confusion in any question double study is better. Escaping abstract mathematics problems result rote learning rather meaningful.

Acharya (2017) told that negative thinking of mathematics, anxieties of mathematics are the main causes those grow up the difficulties. Students should be eliminated those thinking then student can comprehend. Students need to read questions carefully at the time of examination period

“Student should be used given condition to get correct result. In mathematics there are so many methods to get the result of any problem but candidate must be used indicated method for correct answer. Student need to study all question before start the solution, haphazardly solution doesn't match with correct result”.

(Expert C)

“Students must have clear concept of angle of elevation, angle of depression, reflection of object, basic concept of geometry and trigonometry ratios for transition the verbal statement in to figure of height and distance”

(Expert B)

Student should be put the appropriate terminology given by teacher or text book rather than student's own words. Student should be used indicated method in solve the any problem. Better to do abstract questions together with numerical

questions. Read the question at least two times and make the clear concept what is given by question then start the solution is the best. There are so many methods in mathematics for solving the problems among them certain method are more appropriate according to nature of problems. Student solve the problem haphazardly method then it is not true for this situation. Student should be developed clear concept of angles and mathematical terminologies.

Yadav(2074) student should be understood that basic concepts of geometry like angles and constructing the figures then student can solve the problem. Students know the only definition of angles then they can or can't apply in the real situation. But students know the concept of geometry, reflection of object, trigonometric ratios and definition then clearly they can change the verbal statement in to figure.

I conclude that in simplification the problem better to use Jurge polia four step solving method. In case of proving formula what to be get in next side use the formula or definition according to nature of that quantity. It is easy to remember abstract concept if those concept connection with familiar figure. Formula application is not hard work but students need to clear concept of all formula of trigonometry and shall careful mathematical operation in process of solving. Practice parallel questions according to book and reputation maximum times are the main remedies of difficulties. In case of verbal problems change into figure student should be clear in every terminology given in question. Students should have algebraic and geometric both concepts for convert the verbal problem in to figure. Positive attitude should be developed in any content by learner.

ChapterV

Summary, Findings, Conclusion and Recommendations

After doing any research, it is necessary to provide clear summary, findings, conclusion and recommendations drawn from the research. As stated in the chapter I, the purpose of the study was to find the difficulties of students in learning trigonometry at grade X and explore the remedies of difficulties of students in learning trigonometry at grade X. In this chapter summary of study, finding from research, conclusion and area of further research are presented.

Summary

Broadly speaking, trigonometry is a branch of mathematics that studies relationships between lengths and angles of triangles. Mathematics is a language which is basic tool of communication. Daily communication involves the frequent use of mathematical concepts and skill. So mathematical is essential for understanding and interpreting of every discipline. Each subjects are inter related with mathematics contain. Mathematics is a fundamental course for further study and importance for daily life. . Trigonometry develops the critical thinking power of students in any content.

This research entitled, “learning difficulties of students in trigonometry”. The objectives of this study were: to find the difficulties of students in learning trigonometry at grade X and to explore the remedies of difficulties of students in

learning trigonometry at grade X. The design of the study was mixed method design. I applied explanatory sequential design of mixed method design. I had selected two public and two private schools of Kathmandu. Researcher took 155 students from the four schools.

Achievement test and interview were as data collection tools. Five students, three optional mathematics teachers and three mathematics experts were selected for interview. One hundred fifty students were for achievement test. I took interview with five students and three teachers by the help of interview guideline to find the difficulties of students in learning trigonometry. I took interview with three teachers and three mathematics experts to find the remedies of reduce difficulties. I analyzed and interpreted the numerical data by using mean and standard deviation and oral data with the help of conceptual framework as well as review of theoretical literature.

Findings of the Research

Trigonometry is most relevant and importance content in mathematics. This enables student to think critically and abstractly. From the analysis and interpretation of collected data researcher found so many difficulties of student in learning trigonometry. The findings of this study are presented below:

- Mean of obtained mark of students of government school was less than the mean of obtained mark of students of private school this shows that government schools' students had more difficulties in learning trigonometry then private schools.
- From the achievement test mean mark of student was 21.19 and standard deviation was 11.76. This shows that students had difficulties in learning

trigonometry and obtained mark of students were spread out from the mean value.

- The most prominent difficulties in learning trigonometry were to understand the basic concept and lack of the pre-knowledge about trigonometry.
- Students used their own understanding in exam and they didn't care the teachers' voice and terminology of text book. Also they understood misconception of what is trigonometry and what studies are.
- They had problems related to the understanding the simple concept of elevation angle, depression angle, reflection of object, reciprocal of trigonometry ratios, sub-multiple angle and so on. Those were the main reasons which affect understanding the new concept of trigonometry.
- There are many formulae in trigonometry for prove. Proving such formulae was another difficulty for students. Proving without understanding result became rote learning more than meaningful.
- Problem solving is popular with students for solving numerical and calculus problem but to solve abstract problems of trigonometry is another difficulty.
- Students thought that we have to use formulae to prove other questions but formula comes obvious. They had known some formulae and definitions but they didn't organize properly in appropriate place.
- Students want to rote learning more than meaningful, they want exam oriented questions to get high mark in exam without conceptual learning. When the grading system came in SEE then students became lazy.
- Students know the formula of compound angle but they feel confusion in multiple and sub-multiple angles. But they love rote learning rather than meaningful in the abstract content.

- The students of the government schools get opportunity to read optional mathematics only from grade IX. So they didn't have pre-knowledge about trigonometry.
- There was lack of practices of trigonometry problems and proving formulae. Main thing of the difficulty of students was negative attitude towards trigonometry.
- Some of the students used their own ideas. They forgot the process which was given by teachers. Students solve the questions haphazardly unless they forget to read the total question.
- Some students they know the formula but they don't know appropriate use of formula.
- For remedies of difficulties students need to study formula and definition by making chain or pattern. If they study abstract concept by brazing with picture and local materials then they can remember long time.
- Students must have clear concept of angle of elevation, angle of depression, reflection of object, basic concept of geometry and trigonometry ratios for transition the verbal statement in to figure of height and distance
- For remedies of difficulties students should be make mathematical vocabulary for clear understanding of any content and must be familiar with English as well as nepali language.
- All students must have positive attitude toward subject matters then students can learn clearly. Students need to practice parallel problems and reputation habit must be grow up
- For remedies of difficulties students should be develop the habit of reading and writing. It helps to long term remember and clear understanding.

- Students need to make clear concept in geometrical figures, mathematical terminologies as well as definitions it helps to derive the formulae and simplification the problems. Students must be eliminated the habit of negative thinking and anxiety. Student should be practice equally numerical problems and formulae
- For long term memory students need to repeat as possible as more time. Students should spend the maximum time at home so, if they put the formula list and definition chart in their room's wall then maximum time they see that written list for long term memory.

Conclusion

The abovefinding it is concluded that there are abundance difficulties in trigonometry. These difficulties are categorize into six different section .thoseare remembering the formula and definition, understanding the concept, application, simplification of problem, transition verbal problems into figure and formula deduction.

There is lack of basic concept about trigonometry so students feel difficulties in learning abstract concept. They have misconception of what is trigonometry, what are studies and what are the uses of trigonometry. So they don't care teacher's voice and terminology of text book they use their own words and concept for further simplification of problems. They have problemsrelated to understanding the simple concept of elevation angle, depression angle, reflection of object, reciprocal of trigonometry ratios, sub-multiple angle. These are the main difficulties which affectsunderstanding new concept of trigonometry.

Students of the government schools get opportunity to read optional mathematics only from grade IX. They didn't have pre-knowledge about trigonometry that is the main difficulty. Students know some formula and definition but they didn't organize those formulae and definition to prove new formula. Some students they know the formula but they don't know appropriate use of formula that is the main difficulty. Students solve the question according to their known method but question indicates the different method for solution. It is difficulties related to application. There is lack of practice of trigonometry problems and proving formulae.

Main difficulty of students is bad attitude towards trigonometry. For long term memory students need to repeat as possible as more time. Students spend the maximum time at home so if they put the formula list and definition chart in their room's wall then maximum time they see that written list it help to better remember. For remedies of difficulties students should be made mathematical vocabulary for clear understanding of any content and must be familiar with English as well as nepali language.

Recommendation for Further Study

From the finding of the presented study I recommended that which can benefit able to minimize the learning problems in trigonometry. The finding and conclusion of the study were based on the four school of the Kathmandu. So its result may not be generalized in all secondary school (Grade X). I have presented the following recommendation for further study.

- Same study can be repeat in grade XI and grade XII.
- Similar study can be done by taking other learning difficulties of students.

- Comparison of achievement in learning trigonometry between the students of public school and private school.

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Appendix-A

Obtained Mark of Pilot Test and Correlation

Obtained marks of six students in pilot test tabulated below.

Table number:1

Number of students	1	2	3	4	5	6
Total obtained mark in odd questions	19	18	17	18	20	21
Total obtained mark in even questions	15	16	13	15	17	16

Correlation was found by using Karl Pearson's Product Moment Formula.

Table number: 2

Students ↓	(X)	(Y)	$x=X-A$	$y=Y-B$	Xy	x^2	y^2
1	19	15	0	-1	0	0	1
2	18	16	-1	0	0	1	0
3	17	13	-2	-3	6	4	9
4	18	15	-1	-1	1	1	1
5	20	17	1	1	1	1	1
6	21	16	2	0	0	4	0
Sum					8	11	12

Where, A= Assumed mean of total obtained mark in odd questions (X) =19 and B=Assumed mean of total obtained mark in even questions (Y) =16. From the above table $\sum xy = 8$, $\sum x^2 = 11$, $\sum y^2 = 12$ Karl Pearson's formula was used to find the correlation between obtained mark in odd questions and obtained mark in even questions.

$$\text{Correlation coefficient } r_o = \frac{\sum xy}{\sqrt{\sum x^2} \sqrt{\sum y^2}}$$

$$= \frac{\sum xy}{\sqrt{\sum x^2} \sqrt{\sum y^2}}$$

$$= \frac{8}{\sqrt{11} \sqrt{12}}$$

$$r_o = 0.6963$$

$$\text{Corrected correlation coefficient (r)} = \frac{2r_o}{1+r_o}$$

$$= 0.821$$

According to Garret (Garret, 2008, P. 176) interpretation of reliability coefficient based on the following table.

Table number:3

Coefficient	Nature
0.0 - ± 0.20	Indifferent or negligible
± 0.20 - ± 0.40	Present but slight
± 0.40 - ± 0.70	Substantial or marked
± 0.70 - ± 1.0	High to very high

Appendix-B

Obtained Mark of Students, Mean and Standard Deviation

Obtained mark of students of government school

Table number: 4

Obtained Mark (X)	0-10	10-20	20-30	30-40	40-50
Frequency (F)	20	17	6	8	4

Class interval	Frequency (f)	Mid-value (m)	fm	x=m-mean	x ²	fx ²
0-10	20	5	100	-12.25	150.0625	3001.25
10-20	17	15	255	-2.25	5.0625	86.0625
20-30	6	25	150	7.75	60.0625	360.375
30-40	8	35	280	17.75	315.0625	2520.5
40-50	4	45	180	27.75	770.0625	3080.25
	N=55		∑fm =965			∑fx ² =9048.4375

$$\text{Mean} = \frac{\sum fm}{N} = \frac{965}{55} = 17.55$$

$$\begin{aligned} \text{Standard deviation } (\sigma) &= \sqrt{\left(\frac{\sum fx^2}{N}\right)} \\ &= \sqrt{\left(\frac{9048.4375}{55}\right)} = 12.83 \end{aligned}$$

Obtained mark of students of private school

Table number: 5

Obtained Mark (X)	0-10	10-20	20-30	30-40	40-50
Frequency (F)	14	19	44	17	6

Class interval	Frequency (f)	Mid-value (m)	Fm	x=m-mean	x ²	fx ²
0-10	14	5	70	-18.2	331.24	4637.36
10-20	19	15	285	-8.2	67.24	1277.56
20-30	44	25	1100	1.8	3.24	142.56
30-40	17	35	595	11.8	139.24	2367.08
40-50	6	45	270	21.8	475.24	2851.44
	N=100		∑fm =2320			∑fx ² =11276

$$\text{Mean} = \frac{\sum fm}{N} = \frac{2320}{100} = 23.2$$

$$\begin{aligned} \text{Standard deviation } (\sigma) &= \sqrt{\left(\frac{\sum fx^2}{N}\right)} \\ &= \sqrt{\left(\frac{11276}{100}\right)} \\ &= 10.62 \end{aligned}$$

Obtained mark of all students of private school as well as public school

Table number: 6

Obtained Mark (X)	0 – 10	10-20	20 -30	30-40	40 -50
Frequency (F)	34	36	50	25	10

Class interval	Frequency (f)	Mid-value (m)	Fm	x=m-mean	x ²	fx ²
0-10	34	5	170	-16.19	262.1161	8911.9474
10-20	36	15	540	-6.19	38.3161	1379.3796
20-30	50	25	1250	3.81	14.5161	725.805
30-40	25	35	875	13.81	190.7161	4767.9025
40-50	10	45	450	23.81	566.9161	5669.161
	N=155		$\sum fm = 3285$			$\sum fx^2 = 21454.1955$

$$\text{Mean} = \frac{\sum fm}{N} = \frac{3285}{155} = 21.19$$

$$\begin{aligned} \text{Standard deviation } (\sigma) &= \sqrt{\left(\frac{\sum fx^2}{N}\right)} \\ &= \sqrt{\left(\frac{21454.1955}{155}\right)} \\ &= 11.76 \end{aligned}$$

Appendix-C

Formulae List

Researcher was used the following formula for calculate the correlation, corrected correlation, mean and standard deviation.

$$\text{Correlation coefficient } r_o = \frac{\Sigma xy}{\sqrt{\Sigma x^2} \sqrt{\Sigma y^2}} \text{ ----- formula (1)}$$

$$\text{Corrected correlation coefficient } r = \frac{2r_o}{1+r_o} \text{ ----- formula (2)}$$

$$\text{Mean} = \frac{\Sigma fm}{N} \text{ ----- formula (3)}$$

$$\text{Standard deviation } (\sigma) = \sqrt{\left(\frac{\Sigma fx^2}{N}\right)} \text{ ----- formula (4)}$$

Appendix-D

Research Test Questions

Class : 10

F.M. :50

Subject : Opt. Mathematics

Time :1hr 45mins

P.M. :20

Attempt all the questions.

Group 'A' (4×1=4)

Q.N.1 Define an elevation angle.

Q.N.2 What is the formula of $\cot(A+B)$ and $\cos(A+B)$?

Q.N.3 which quadrant lies the angle 1111° ?

Q.N.4 List the formula of $\cos 2x$ in terms of \sin and \tan .

Group 'B' (6×2=12)

Q.N.5 The angle of elevation of a bird from the point 400 feet above a pond is 30° and the angle of depression on its image in the pond is found to be 60° . Draw the figure only according to above information.

Q.N.6 Construct the graph of $\sin \theta$ ($0^\circ \leq \theta \leq 90^\circ$)

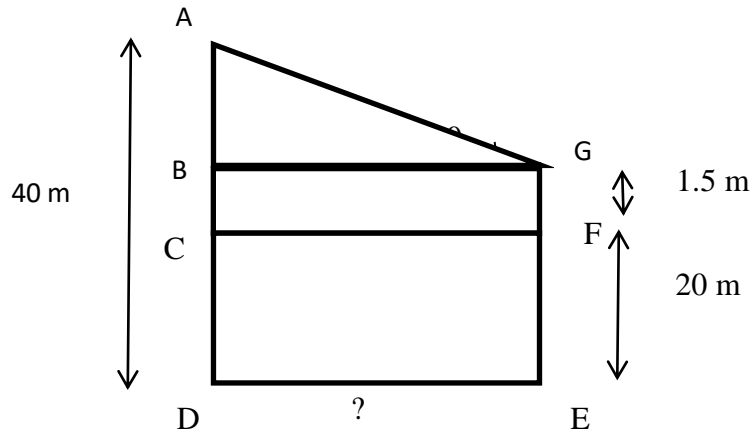
Q.N.7 Prove that the following by using $\tan 60^\circ = \sqrt{3}$ and $\cos 60^\circ = \frac{1}{2}$

$$\frac{1}{\sin 10^\circ} - \frac{\sqrt{3}}{\cos 10^\circ} = 4$$

Q.N.8 If $\cos \alpha = \frac{4}{5}$ and $\cos \beta = \frac{7}{5\sqrt{2}}$ then prove that: $\alpha + \beta = \frac{\pi}{4}$

Q.N.9 Find the value of $\sin 18^\circ$ without using the trigonometry table?

Q.N.10 Describe the following figure on your own words?



Group 'C' (6×4=24)

Q.N.11 If $A+B+C=270^\circ$ then prove that:

$$\sin A \cos B \sin C + \cos A \sin B \sin C + \sin A \sin B \cos C = \cos A \cos B \cos C$$

Q.N.12 If $A+B+C=\pi$ then prove that:

$$\cos 2A - \cos 2B - \cos 2C = 4 \cos A \sin B \sin C - 1$$

Q.N.13 Simplify: $\frac{\sin^2 A - \sin^2 B}{\sin A \cos A - \sin B \cos B}$

Q.N.14 Simplify: $\sin^4 \frac{\pi}{8} + \sin^4 \frac{3\pi}{8} + \sin^4 \frac{5\pi}{8} + \sin^4 \frac{7\pi}{8}$

Q.N.15 Derive the formula (2+2=4)

a. $\sin C + \sin D = 2 \sin \frac{C+D}{2} \cos \frac{C-D}{2}$

b. $\cos C + \cos D = 2 \cos \frac{C+D}{2} \cos \frac{C-D}{2}$

Q.N.16 Show that (2+2=4)

a. $\sin 3A = 3 \sin A - 4 \sin^3 A$ b. $\cos \theta \cos (60^\circ - \theta) \cos (60^\circ + \theta) = \frac{1}{4} \cos 3\theta$

Group 'C' (2×5=10)

Q.N.17 A vertical tower stands on a horizontal and is surmounted by a vertical flagstaff of height h . At a point on the ground the angle of elevation on the bottom of the flagstaff is α and that of the top of the flagstaff is β then prove that the height of the tower is $h \tan \alpha / (\tan \beta - \tan \alpha)$.

Q.N.18 Solve the following two equations and compare which equation gives the more values of θ for the range 0° to 90°

a. $\sin 3\theta + \sin \theta = \cos \theta$.

b. $\sqrt{3} \cos \theta + \sin \theta = \sqrt{3}$.

Appendix-E

Interview Guidelines for Students

Date of interview :.....

Name of student :.....

Roll no :.....

Sex :.....

School name :.....

The interview with students had been taken on the basic of the following topics:

- Face difficulties on trigonometry learning
- Basic knowledge about trigonometry
- Problems/ difficulties on theorem deduction
- Simplification of problems of trigonometry
- Transition the verbal statement in to figure
- Difficulties in application
- Difficulties in understanding /conceptual
- Difficulties in remembering / knowledge

Appendix-F

Interview Guidelines for Teachers

Date of interview :.....

Name of teacher :.....

Qualification :.....

Teaching experience :.....

Sex :.....

The interview with teachers had been taken on the basic of the following topics:

- Problems of students in trigonometry
- Difficulties of students related to formulae proving
- Difficulties of students in application
- Difficulties related to transition the verbal statement in to figure
- Problems in understanding
- Simplification of various types of the trigonometric problems
- Difficulties of students in remembering

Appendix-G

Interview Guidelines for Mathematics Experts

Date of interview:.....

Name of expert:.....

Qualification:.....

Field work/ teaching experience:.....

Sex:.....

The interview with mathematics expert had been taken to find the remedies of difficulties of students in learning trigonometry on the basis of the following topics:

- Problems in understanding
- Difficulties of students in application
- Simplification of various types of the trigonometric problems
- Difficulties of students in remembering
- Problems of students in trigonometry
- Difficulties related to transition the verbal statement in to figure
- Difficulties of students related to formulae proving
- Not able to search for linkage between different ideas and ideas
- Not interested to understand trigonometric theoretical concept