CHAPTER I

INTRODUCTION

Background of the Study

Mathematics is a science which involves logical reasoning, drawing conclusions from assumed premises, systematized knowledge, and strategic reasoning based on accepted rules, laws, or probabilities. Also mathematics is a specialized language which deals with form, size, and quantity. On the basis of nature of mathematics it is divided into various parts such as trigonometry, algebra, geometry, analysis, arithmetic, foundation and applied etc. which are essential part of human life, however it is more complicated to learning in school level students. Among them I select trigonometry to identify the difficulties in learning trigonometric solving problem in school level. During my study phase, me and most of my friends found this topic as more a difficult and at my teaching period I found that most of the student are faced difficulties on his/her class work, homework and exam time of trigonometry. Also when I study the various journals and thesis I found most of them related to only one distinguishing difficulties of learning trigonometry but my research is most concern in solving trigonometric problem. So I am still very interested in this topic mainly because of its complex nature.

Trigonometry is an influential and inseparable topic of mathematics in a school curriculum. It is applied in all current branches of mathematics as well as in Science. In support of this observation Weber (2005) state that trigonometry is an important course in the high school curriculum. Understanding trigonometric functions is a pre-requisite for understanding topics in Newtonian physics, architecture, surveying, and many branches of engineering. Further, as trigonometry is one of the earliest topics of mathematics that links algebraic, geometric, and graphical

reasoning, it can serve as an important precursor towards understanding pre-calculus and calculus. Trigonometry is a product of algebraic techniques, geometrical realities and trigonometric relationships. Trigonometry deals with the study of angles, triangles, and trigonometric functions.

According to the Achrya (2017) mathematics is the one of the most important subject in our human life. Without the knowledge of mathematics, we can say nothing possible in the world. Now a day's mathematics is globally accepted but locally useless. Mathematics has been accepted as an importance component of formal education from ancient period to the present day. That's why I would like to investigated difficulties and cause of problem in learning trigonometry in school level students.

After I studied the different journal, thesis and other research materials (eg. Acharya 2017; Ghimere 2017; Thapa 2016; Johnson &star 2015).I found that there were various causes of difficulties in learning trigonometric problem such as lack of motivation, home environment, student's attitudes, pre-knowledge. In that research, researcher didn't focused on where the students faced difficulties. So, the gap I found in my review, that's why, I selected this area for research. I think my research fulfill this research gap.

Statement of the Problem

In my two years teaching experience I feel that students faced difficulties in learning trigonometric problem and my own experience at school level I also felt difficulties in learning trigonometric problem. So, I am interested to know where and why students faced difficulties in learning and solving trigonometric problem. When I studied various journals and thesis I found most of them related to distinguishing the causes of difficulties in learning trigonometry but my research is most concerned in

where are the difficulties to solving trigonometric problem. I feel there are so many problems in learning trigonometry. So, I want to know what are the problems faced by students and what factor causes hindered to learn trigonometric problem. So I selected this topic for research.

The objective of this study mainly concerned to investigate the difficulties in learning trigonometric problem in grade IX students. Trigonometry is very important in recent mathematics curriculum as well as it has a great utilization in the different field such as to count the height, slope, length etc. It is used in different functions like as sin, cosine, tangent and its reverse function also. But most of the students feel difficulties to use this function in appropriate problem.

Significance of Study

Mathematics is essential everywhere so there is no any field which can run without mathematics. It is essential part of school level curriculum. Furthermore, trigonometry is one of the most essential and applicable branch of mathematics. So, trigonometry has been given as an important place in school level curriculum. Most of the students faced difficulties in solving trigonometric problem. That's why student afraid and dislike trigonometry. The main objective of this study was to find the difficulties and it's causes in learning trigonometry. This research will help teachers to come up with better ways of minimizing prominent difficulties in trigonometry as well as in many branches of mathematics. Hence, the intention of this study was to identify and analyze the common difficulties of grade IX students from four secondary schools and to find the root causes of these difficulties. After identifying the difficulties, it helps to teacher and stakeholder to minimize the difficulties. Moreover the significant of this study are as follows:

- It provides the appropriate information about the difficulties faced by the students in learning and solving trigonometric problem,
- This study will helps to further study about the problem of trigonometry,
- This study will helps to identify the factor affecting in learning trigonometric problem,
- This study will help for students to minimize the problem which influence for their learning.

Objective of the Study

The objectives of this study were as follows

- To explore the difficulties in learning trigonometric problem solving at grade IX,
- To analyze the causes of difficulties in learning trigonometric problem solving at grade IX

Research Questions

The following research questions will use in the study

- What are the conceptual difficulties in calculating angular value of trigonometry problem?
- What are the Procedural difficulties in learning trigonometry problem?
- In which steps students faced the difficulties to solving trigonometric problem?
- What are the causes of difficulties in learning trigonometric problem?

Delimitation of the Study

The delimitations of this study are as follows:

- This study will be limited to the student of optional mathematics for secondary level in Kaski district,
- This study was limited in the private school.
- The study was concerned only with the student of grade IX.
- This study was concern only trigonometry part of optional math of grade IX.
- This study was only used only three tools such as achievement test, in-depth interview and class observation note.
- This study was taken only in100 students.

Definition of Related Terms

Difficulties in Learning. Difficulties in learning means the difficulties face by students in different steps of learning and solving trigonometric problem, which is related to conceptual and procedural difficulties.

Conceptual Difficulties. Conceptual difficulties are related to concept of trigonometric term and connection of definition or relation with problem. (Such as writing definition, finding angular value and determine trigonometric ratio)

Procedural Difficulties. Procedural difficulties are the disability to execute action sequences to solve trigonometric problems. (Such as way to solve, using formula and mathematical operation)

Difficulties in Problem Solving. Difficulties in problem solving are unable to describe, analyze and solving trigonometric problem, which are related to mathematical process. It includes understanding the problem, devise a plan, carry out the plan and looking back

CHAPTER II

LITERATURE REVIEW

A literature review is a comprehensive summary of previous research on a topic, which helps to identify new ways to interpret prior research**.** According to Drowns (2005) a literature review is a descriptive, analytic summary of the existing material relating to a particular topic or area of study. In this research some articles, scholars and research have contributed considerable effect in these topics. For our subject matter, some available and related studies have reviewed. This topic has been devoted into the journals; previous researches, Reports, other published and unpublished document related to the subject are as follows:

Learning Mathematics

The acquisition of knowledge or skills through math study or their experience is learning. Students' need and interest with their preexisting level of knowledge and skills towards mathematical concepts are the major determining factors of lower achievement in mathematics. According to the Acharya(2017) student’s interest and positive feeling of mathematics increase the pass in mathematics. The parents' meaningful engagement with quality time for helping to learn to the students at homes, due to poor economic is another pertinent cause of their low performance. Negative explanation about mathematics from the teacher’s side parents and other person created frustration and anxiety in mathematics students; pass in mathematics depends on student’s labor in learning mathematics. Lack of parent’s awareness, interest of the subject matter affects their children to study other subject. So, it should be eradicate barriers factors influencing to learn mathematics and make mathematics learning enjoyable in our context

Another factor considered causing special concern is the factors different to mathematics. The basic nature of mathematics including its language and the skills involved makes it difficult for students to learn. The nature of mathematics like abstractness, accuracy, symbols and notations are dealt as part of mathematics education as potential factors causing difficulty in learning it. As the same ways, according to the Guragin (2016) student faced two type of difficulties in school level learning mathematics, one is semantic for which student suffer in mathematics due to the specific term having different meaning in other discipline and other is syntactic difficulties, which is in the language .Another study done by Ghimire (2017) investigate the result that poor learning environment at home and school, poor economic status, traditional teaching style, negative learning attitude, not using the ICT teaching/learning mathematics, paper-pencil evaluation are the main cause of low achievement in learning. Similarly Usman and Hussaini (2017) also conclude that the error in process skill seems more pronounced in the use of formula than the right-angled triangle method. This error may be due to the fact that students failed to understand and describe what is required by the questions. Most students did not manage to perform the operation especially when numerical values are involved. This results in failure to solve the problems. Using a formula is a problem solving strategies that students used to find answers to trigonometry problem. To solve the problem students must choose the appropriate formula and substitute data in the correct places of a formula. According to the (Pachman et al., 2013) in order to perform algebraic manipulations using only declarative knowledge, an individual must precede step-by-step, recalling each step individually into working memory as an instruction and then operating on it. Procedural knowledge refers to automated processes which do not directly consume working memory and are therefore more

efficient. A learner can transition from declarative knowledge to procedural knowledge through the acquisition of schemas, resulting from attentive practice.

Learning Difficulties

Any learning or emotional problem that affects a person's ability to learn, get along with others is called learning difficulties. A learning difficulty is a condition that can cause an individual to experience problems in a traditional classroom learning context. It may interfere with literacy skills development and math which can also affect memory. A child or adult with a learning difficulty may require additional time to complete assignments at school. As a shame the thesis written by Thapa (2016) indicate on the topics "Learning difficulties in trigonometry" focus on the same topic as mine which conclude that there were not sufficient material for learning trigonometry, teacher had not clear concept about lesson of trigonometry, teacher used lecture method in the classroom ,teacher had not implemented the modern technique ,methods and material for trigonometry teaching and learning so that student had confusion to understand trigonometry which makes learning trigonometry more difficult.

DSF Literacy Services (2015) said that children have learning difficulties underachieve academically for a wide range of reasons, including factors such as: sensory impairment (weaknesses in vision or hearing); severe behavioral, psychological or emotional issues; English as a second language or dialect (ESL or ESD); high absenteeism; ineffective instruction; or, inadequate curricula. These children have the potential to achieve at age-appropriate levels once provided with programs that incorporate appropriate support and evidence-based instruction.

Articles by Mensaha (2017) on the topic "Ghanaian Senior High School Students' Error in Learning of Trigonometry" also focused the same issues as me. In

his study he showed that most students make error in process skill and transformation irrespective of the method used in solving trigonometry problems. There was no error found in students' reading skills. The number of students who made encoding error and carelessness was relatively low. The students' error in solving trigonometry problems was due to their weaknesses in basic arithmetical operations.

Pre-knowledge

Pre knowledge about trigonometry is the knowledge the learner already has before they meet new information about trigonometry. A learner's understanding of a trigonometry can be improved by activating their prior knowledge before dealing with the text, and developing this habit is good learner training for them

Articles by Hailikari, Katajavuori and Pharm (2008) conclude that pre-knowledge assessment that happens at the beginning of the course may be an important tool for instructional support. By assessing prior knowledge, it is possible to identify students who are struggling with their studies. Prior-knowledge assessment results can be used for various purposes: identifying students who are struggling with their studies; finding an appropriate level at which to start the course; provision of feedback to students; bridging the gap between instructors' expectations and students' actual knowledge base; and grouping students according to their abilities. Similarly, According to the Yadav (2074) the main causes of students difficulties in learning mathematics is poor pre-knowledge and lack of basic knowledge of subject's matters. Teachers play the role of facilitator and guides of students in classroom. Khan (2014) concluded that the research work as the previous knowledge of the students played a significant effect on student's achievement in trigonometry and the previous knowledge could be helpful to enhance the students learning achievement.

Similarly, Samuel et al. (2016) concluded that most of the students failure to grouping like terms, manipulating the sings and symbols. Also they found that the students have lack of pre requisite knowledge such as simplification and manipulation of algebraic expressions and equations. Bhandari (2017) is also conclude that many difficulties that children face in leaning mathematics in the lack of understanding of lower level concepts and lack of clarity about different rules that are often conflicting can lead to misconceptions and affect mathematical learning.

Misconceptions on Learning Trigonometry

A misconception is a condition that's wrong because it's based on faulty thinking that is wrong. Errors and misconceptions occur when students make wrong generalization of an idea. Student constructs wrong rules without reference to the conceptual content. The student has misleading idea about trigonometry is misconception on learning trigonometry. According to the Orhun (2015) the performances of the student are confirmed that students' mistakes are made very systematically. It was seen that the subject of trigonometry stands on the level of establishment of relationships between the angles and triangles. This shows that many students had not developed clear concepts for trigonometry, and that some of them use algebraic notation as informal and inconsistent personal shorthand. The main reasons of students' mistakes are due to teaching method. Similarly Mohyuddin and Khalil (2016) also conclude that mathematical difficulties might be caused due to a misconception. Other factors may include carelessness, problems in reading or interpreting a question and lack of numbers knowledge misconception, on the other hand, is the result of a lack of understanding or in many cases misapplication of a rules or mathematical generalization.

Student Attitude/ Behaviors toward Mathematics

Attitude toward mathematics is defined as general emotional disposition toward the school mathematics Joshi (2017). Hagoramagara (2015) indicate that the learners‟ inappropriate behavior as expressed by learners during a Grade 10 mathematics lesson played it out in three categories: (i) disruptive behavior; (ii) lack of concentration and inert of learning behavior; and, (iii) antisocial behavior.

Similarly the another study done by Joshi (2017) also conclude in his thesis most of the students had positive attitude towards the mathematics in grade IX but many of the student have facing many problem such as; lack of student confidence level, mathematical anxiety, lack of guardian's qualification, home environment, social cultural, social tradition, social discrimination, lack of trained teacher, lack of teaching material and due to other physical facility are the main factor that affecting student's attitude towards mathematics. Also khadka (2006) conclude in his thesis that the school condition, social economic status, teachers attitudes and expectation usefulness of mathematics mechanism distribute of incentive, average of focused children, trained of tuition, trend of grace mark system, not availability of text book, low interaction between student, teacher and parents influenced the attitudes of learning mathematics.

Impact of Home/school Environment in students learning

A child's home environment has significant effects on learning and school performance, the mother's education level had the single most significant impact on a young child's academic success as a similar of father's education and occupation, economic condition, size of family and other factor take the importance role for learning. That's why home environment is the major factor to affect the learning difficulties in school level students. According to the Acharya (2017) home is first

school of child and mother is first teacher. All children education depends on their home environment. Good home environment enhances students' achievement in mathematics. Uneducated person unaware about the importance of mathematical knowledge in their life and they cannot force to learn mathematics to their child. Students pass in mathematics from all schools depends on their home environment and they learn everything from their family member characters and their society behaviors in this study parents are not aware in child education.

Karki (2018) indicate that the home environment is the key factor in good achievement of students. He conclude on his thesis 12 main parts of home environment such as father's occupation, mother's occupation, father's and mother's education, father's incomes, mother's incomes, numbers of family members, study materials, study room, study time, household workload and parent's behaviors are the major factor on mathematics achievement of girls students.

In the same context Sharma (2015) also don his research" Impact of home environment on mathematics achievement tharu student's. In this research he also point out medium family children obtained better marks then small and big family children's, family using Nepali language at home and parents education create batter learning home environment, family size, study time at home, social belief, parents education, parent's occupation and social tradition are the major factors on mathematics achievement of tharu student.

Lack of Motivation

Lack of proper motivation and guidance on methods of learning Mathematics and meta-cognitive and self-regulatory strategies are the main difficulty in learning mathematics. Lack of Peer interactions and parental involvement are the another main causes in difficulties arising in learn mathematics. Unlike other subjects, in

Mathematics, it is very difficult to follow the content if the student misses one class.

Sofowora (2014) observed anxiety and lack of motivation in his research he conclude that anxiety as a result of negative attitude and bad experiences in addition to lack of motivation (either intrinsically, extrinsically, or task oriented) have a potential impact on success rates in bridging mathematics among the students. He found that many pupils generate negative attitudes towards mathematics throughout the course of their academic lives, and on occasions present an authentic aversion to the discipline. For most pupils, the subject is not a source of satisfaction, but rather one of frustration, discouragement, and anxiety. Many of them, even some of the most able, find mathematics to be just a tiresome chore. It is confirmed that students who attributed success to intrinsic motivational factors were less anxious about mathematics; they had greater expectations of success, as they were more geared towards mastering the subject, being self-reliant and working independently for success. However, those who attributed their failure in mathematics to anxiety, bad experiences/negative attitude and extrinsic motivational factors (such as fear of parental apathy, peer pressure satisfaction etc.) were less oriented to mastering the subject, and they showed poorer academic performance. Similarly, Deci (1971) indicate that the lack of motivation demonstrated by students is a problem, because the presence of intrinsic motivation in students produces school success. Intrinsically motivated students perform activities simply for the enjoyment and satisfaction that comes from completing the activity In school, these students engage in behaviors such as working for a sustained period of time, taking more risks, and working out creative solutions to problems. It is easy to see why intrinsically motivated students do well in school.

Theoretical Framework of Study

Learning with understanding is important, and the aim of this study is to investigate students' learning difficulties in trigonometry. However, it is not a trivial issue how to assess understanding. Theoretical concept is related to mathematical understanding meaning being able to make mental connections among trigonometric objects and procedures. In the problem based learning model the student's turn from passive listeners of information receivers to active. Problem based learning affect positively certain other attributes such as problem solving, information acquisition, and information sharing with others, group works, and communication etc. The problem-solving approach is more useful than the traditional approach; several studies focus the change in knowledge and skill levels that occur with problem-solving techniques. According to the Eisenhart (1991) the theoretical framework guides and should resonate with every aspect of the research process from define of research problem, literature review, methodology, presentation, and discussion of findings as well as conclusion.

To analyze and find the suitable solution in the area of difficulties in learning trigonometry, Polya's Problem-solving is the cornerstone for my research. The main reason to use Problem-solving method for my topics of learning difficulties in trigonometry is to be able to minimizing the problems. It is strongly believed that the most efficient way for learning mathematical concepts is through problem solving. So, that children need to learn to think about quantitative situations in insightful and imaginative ways, and that mere memorization of rules for computation is largely unproductive. Of course, if children are to learn problem solving, their teachers must themselves be competent problem solvers and teachers of problem solving. The techniques discussed in this and the coming sections should help you to become a

better problem solver and should show us how to help others develop their problem-solving skills. In 1945 George Polya published the book How To Solve It which quickly became his most prized publication. It sold over one million copies and has been translated into 17 languages. In this book he identifies four basic principles of problem solving.

Polya's First steps: Understand the problem

Polya's Second steps: Devise a plan

Polya's Third steps: Carry out the plan

Polya's Fourth steps: Looking back

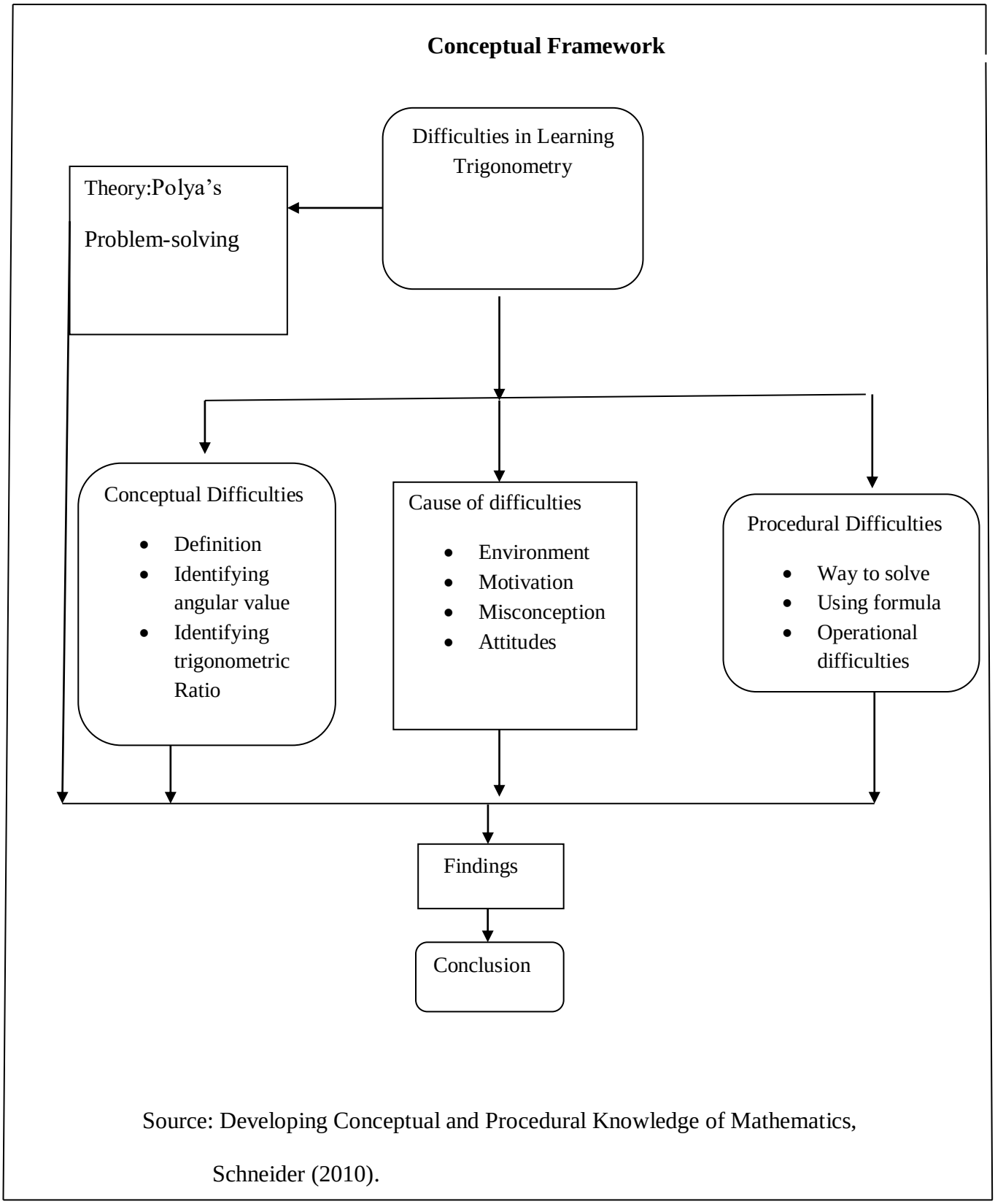
The above four steps are more effective steps of solving any mathematical problem which gives roadmaps for solving.

A robust understanding of trigonometric functions requires different algebraic, geometric, and graphical aspects but due to the complex nature of the topic, Despite limited, the literature on trigonometry learning and teaching reveals that it is a difficult topic for students, According to the above research thesis and articles review we conclude that there are many factor affected by school level student in learning trigonometry which are incomplete knowledge of number facts, lack of basic knowledge about trigonometry, misconception on subject matter, lack of interest and negative felling towards mathematics, specific term having different meaning in other discipline, lack of teaching material, lack of motivation, home environment, etc. The affective domain factors, students' anxiety, motivation and attitudes can enhance, inhibit or sometimes prevent active learning. Lecturers are therefore enjoined to be aware of these traits in their students and help them overcome it for improved performances in bridging mathematics.

Conceptual Framework

Conceptual framework refers the mental picture of the research which gives the life to a research. When we thing something about research on our mind that mental structure is known as conceptual framework. According to the Miles and Huberman (1994) conceptual framework as a visual or written product, one that explains, either graphically or in narrative form, the main things to be studied, the key factors, concepts, or variables and the presumed relationships among them. Conceptual framework is the analytical management or design, which contains difficulties of students in learning trigonometry and its causes that affecting learning trigonometry. I made this conceptual framework by the help of literature review, supervisor and peer discussion to make the study specific, systematic and easy.

Conceptual Framework



Source: Developing Conceptual and Procedural Knowledge of Mathematics, Schneider (2010).

Above conceptual framework shows that direction of research. My research "Difficulties in learning trigonometric problem" is based on the theory of Polya's Problem-solving that assumes more effective for trigonometric problem solving. On the basis of Polya's problem solving my research found the conceptual and procedural difficulties in learning trigonometry. In the conceptual difficulties this research mostly concern in student's difficulties in definition, calculating angular values and identifying trigonometric ratios. Similarly, in conceptual difficulties this research mostly concern in students difficulties in way of solving, using formula and mathematical difficulties. These difficulties were investigated on the basis of polyas problem solving stage such as Understand the problem, devise a plan, carryout the plan and looking back. After that I will find those factor which influence to learning trigonometry. There are many factors that affect the learning and solving trigonometric problem to secondary level student. School learning environment, family condition, motivation; Attitudes play a vital role to affect the learning trigonometry in school level. After finding the student's difficulties and causes of difficulties I analyzed the primary data on the basis of general inductive approach.

CHAPTER III

METHODS AND PROCEDURES

This chapter deals about the research design of the study, study area and selection of respondent, data collection procedure and data analysis procedure.

Research Design

A research design is a detailed plan for collection and analysis of the data. It is also a way of research that provides the direction for researcher to achieve the goal. I selected case study research design because this research was qualitative and the main objective of this research was to explore the learning difficulties and analyze the causes of learning difficulties in trigonometry. For this the student who had difficulties in learning trigonometry was my case. So, main concern of this research was to find overall difficulties in learning trigonometric problem in grade IX.

Study Area and Selection of Respondents

In my research I selected four private secondary schools of Kaski district for data collection. Because in my teaching experience in one school of Kaski district namely Birendra Memorial Secondary School, I found there were some students who faced difficulties in learning trigonometry. So, for my research sample I selected this school and other three schools namely Shree Puspa Sadan Secondary boarding school, Shree Nilgiri English Boarding School and Saint Francis Boarding School. Among the students of grade nine, I selected 100 students for sample who learn optional mathematics in above selected school. Among hundred students seven students whose performance was not satisfactory were selected for in-depth interview. Non-probability sampling with special reference to purposive sampling was used to select the sample for this study because purposive sampling as involving selecting certain

units or cases based on a specific purpose rather than randomly. Purposive sampling provided greater depth of the information from a smaller number of units.

Data Collection Tools

Data collection tools are the major component for this research because of all result and conclusion depends on the collected data. In my research I used achievement test, in-depth interview and classroom observation note as the tools to fulfill the objective of study.

Mathematics achievement test. Mathematics achievement tests measure student's understanding of a subject area or skills base. Achievement procedure is an examination to identify an individual's specific areas of weakness and strength in order to determine a condition of students. Achievement testing in mathematics typically provides a level for the student's mathematical skills. In my research I selected achievement test to find the area of student's difficulties. For this I make level wise question as simple to complex with the help of Bloom taxonomy.

Reliability and validity of test. For testing reliability of the research I took pilot test. I selected ten students for pilot testing in sample population. The reliability coefficient is 0.76(Appendix-B), which was obtained from the pilot test. This coefficient shows that the mathematics achievement test paper (Appendix-A) was reliable or high to very high correlation coefficient (According to the Garnet, 2008). Also for the validation of the test, I used sequence and scope table and curriculum of the grade nine developed by CDC, and also I consulted with the supervisor of the research.

In-depth interview. In qualitative data collection method, in-depth interviews offer the opportunity to capture rich, descriptive data about student's behaviors,

attitudes and perceptions, and unfolding complex processes Hagoramagara (2015). Interview is the one of the primary sources for data collection. So, to find students learning difficulties and causes I selected in-depth interview. First of all I took achievement test for finding area of learning difficulties. On the basis of this achievement test I selected seven students whose performance was not satisfactory for in-depth interview. I took unstructured interview on the basis of students learning difficulties. Interview gathers more in-depth data about student's problems, why they felt trigonometry is difficulties and views about mathematics more easily. Generally student's interviews aimed to explore the views on factors relating to their behavior and performance during mathematics lessons.

Classroom observation note. To identify the cause of difficulties in learning trigonometry, classroom observation note was used. I observed two classes Birendra Memorial English Boarding School and Puspa Sadan Secondary boarding school. The purpose of the class observation was to take fresh information from classroom while running the class. My observation totally depend on students activities in classroom, learning environment, use of teaching materials and teaching methods.

Data Collection Procedure

After, decide the sample and data collection tools of the study, I went to the school. At first I meet with principal and he gave me authority to take mathematics achievement test, in-depth interview and classroom observation. Firstly I took achievement test this test gave me the area of difficulties. On the basis of area of difficulties I took in-depth interview for seven students whose performance was not satisfactory. This in-depth interview gave me the core difficulties and causes faced by students. After that I observed two classes of Birendra Memorial English Boarding

School and two classes of Puspa Sadan Secondary boarding school to find out the causes of difficulties

Data Analysis Procedure

The data analysis procedure is important things for qualitative research. In this study the primary data were presented and analyzed. I collected the data from primary sources by achievement test, in-depth interview and observation. Mathematics achievement test gave me the area of learning difficulties. Based on this area I took in-depth interview and also I observed the class of grade IX of selected school. The obtaining data were analyzed by general inductive approach. According to (Thomas 2006) the qualitative data analysis requires the intellectual and conceptualizing processes that are essential to transform raw data into meaningful findings. A general inductive approach for analysis of qualitative data analysis is described as:

(a) Condense raw textual data into a brief, summary format;

(b) Establish clear links between the evaluation or research objectives and the summary findings derived from the raw data; and

(c) Develop a framework of the underlying structure of experiences or processes that is evident in the raw data.

The interview of students, classroom observation report and tested report of question were transcribed properly. The collected information from achievement test and interview was categorized in to the conceptual and procedural difficulties in learning trigonometric problem. Achievement test give the area of student's difficulties. The performance of students was scanned and analyzes it on the basis of in-depth interview. The primary data were translate, coding, interpreted and I make theme. In this study the data were analyzed by general inductive approach

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

This chapter present in details data analysis, presentation, results and discussion of the study by using general inductive approach. The main objective of this research were to explore the difficulties in learning trigonometric problem solving at grade IX and to analyze the causes of difficulties in problem solving of trigonometry at grade IX.

To fulfill the first and second research objective I took achievement test and for third question in-depth interview and observation were took. On the basis of intended objective and constructed tools for collecting the primary data I visited to research field. The data obtained from the field were presented in the following difficulties: conceptual difficulties and procedural difficulties. After that cases of difficulties were analysis in the following topics: misconception on trigonometry, Impact of Home Environment, lack of motivation, prior-knowledge. The data interpreted and analyzed by the information taken from mathematics achievement test, in-depth interview and observation. These data were analyzed by general inductive approach method. Analysis of the study had carried out under the following major heading corresponding to objective of the study.

- Difficulties in learning trigonometric problem solving
- Causes of difficulties in trigonometry problem solving.

Difficulties in learning trigonometric problem

Trigonometry is a difficult subject for school level students to learn due to its complex mathematical structure and due to abstract nature of mathematics Usman and

Hussaini (2017). Most of the students feel difficulties when they do not understand how to reach a result of given trigonometric problem from the concept. Students have needed to develop both conceptual and procedural knowledge to learning trigonometry. Johnson & Schneider & Star (2015) is widely agreed that conceptual knowledge often supports and leads to procedural knowledge. In this research the common difficulties that faced by students are classified as conceptual and procedural difficulties which are given below:

Conceptual Difficulties

Conceptual knowledge in trigonometric is the knowledge that of understanding the concepts, trigonometric terms, principles, ratios etc. Conceptual difficulties in trigonometry means that the student has not clear concept of trigonometric terms, to find angular values and determining trigonometric ratios. According to the Kiat (2005) conceptual difficulties show a failure to grasp the concepts in a problem and a failure to appreciate the relationships in problem. Abstract reasoning and conceptual thinking are often problematic areas for secondary level student. This study concerned to determines the conceptual difficulties such as student's difficulties in definition, student's difficulties in angular value, student's difficulties in trigonometric ratio.

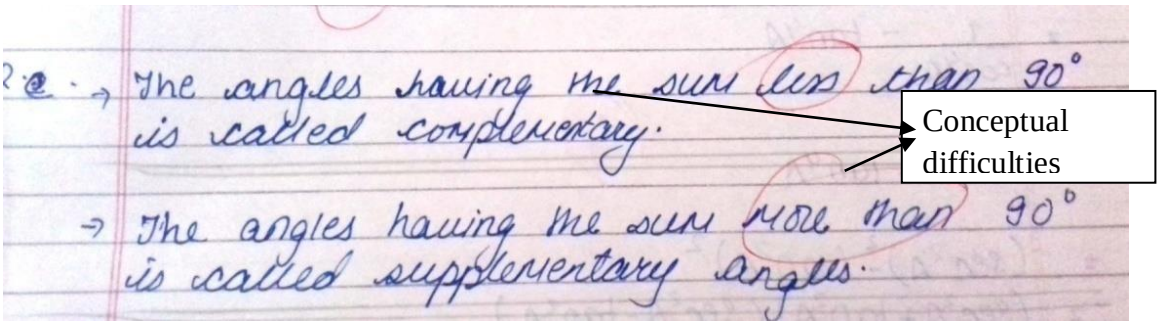
Student's Difficulties in learning definition. Definition is that things which are defined on the basis of undefined and defined term, it is necessary to understand the relevant definition to learn any respective concept of mathematics Tappenden (1996). Difficulties of trigonometric terms are that the student unable to comprehend the meaning and relation of this terms linking with problem. Trigonometry is a significant part of mathematics because of it councils the widely used concept on recent world. According to Wu (2002) definitions are important in mathematics, without the precise definitions of concepts, logical explanations cannot be given and

without explanations, mathematics becomes nothing. To determine the difficulties in understanding the definition then I made three trigonometric questions for this. The performance of students in this domain is given below :

Q. No.	Correct answer of question	Partially correct the question	Wrong answer of questions	Not attempt the questions
1 (a)	15	22	33	30
1 (c)	17	12	35	36
2 (e)	26	23	40	11

Above table shows that in question no.1(a), among 100 students, 15 students gave correct answer, 22 students wrote partially correct answer, 33 students wrote wrong answer and 30 students didn't attempt this question. In question no 1(c), among 100 students, 17 students wrote correct answer properly, 12 students wrote partially correct answer, 35 students wrote wrong answer and 36 students didn't attempt this question. In question no 2(e) among 100 students, 26 students wrote correct answer properly, 23 students wrote partially correct answer, 40 students wrote wrong answer and 11 students didn't attempt this question. The above table shows that few number of students were able to attempt correct answer of all questions. Most of the students were feel difficulty in definition. Students know what to solve and what things to do in any terms like: sexagesimal, centesimal system, radian, complementary and

supplementary angle in trigonometry but they had not good concept of that definition. The representative picture of solution as follows;



In the above answer student was not gave correct definition of supplementary and complementary angle. This shows student had lack of clear concept about supplementary and complementary angle. In question no. 2(e) researcher asked, what is supplementary and complimentary angle? Most of the student wrote that angle having the sum less than 90 is complementary and angle having the sum more than 90 is supplementary angle. But the answer is complementary angles form a right angle and have a sum of 90 degrees and the Supplementary angles form a straight line and have a sum of 180 degrees.

Interview with student is as follows (where R represent researcher and S represent student.):

R: Are you listened the term supplementary and complementary angle?

S_1: Yes, I listened the term supplementary and complementary angle previously but I have not clear knowledge about it.

R: Do you know acute angle and right angle?

S_1: yes sir, the angle which is less than 90 is called acute angle and the angle having 90 is called right angle.

R: Which property is required to be complementary angle and supplementary?

S_1:I think less than 90^0 and more than 90^0

R: (After justifying) Is this your answer right?

S_1: oh...no sir, complementary angle have a sum of 90^0but I write less than 90^0 and supplementary angle have a sum of 180 degrees but I write grater then 90^0.

From the above response of student shows that he had difficulties in complimentary and supplementary angle. At the time of interviewed he gave clear definition of about acute angle and right angle. After that he confused to identify the using property in complimentary and supplementary angle. He had good knowledge about acute angle and right angle. But he had not good knowledge to connect complementary angle with right angle whose sum is 90 and supplementary angle with straight line which sum is 180^0. According to the (Coffield et.al. 2004) most of the research and practices went forward in the face of significant difficulties in the confusion of definitions surrounding the conceptualization disturbing cognitive styles and learning styles

Student's difficulties in identifying angular value. Student's difficulties in angle measure can be considered as the most basic problem to determine the trigonometric value like radian, degree etc. Most of the student face the difficulties with the angle measure in degrees, especially with negative angles and angles larger than 360^0. Orhun (2001) also supported that student's difficulties in the measure of arcs subtending given angles, and vice versa, noting that the identifying the angles from given arc lengths was more difficult for the students.

To identify the difficulties of student in calculating angular value, I used the diagnostics test. In this study five questions were asked about angular value. The performance of students is given as follows:

Question number	Correct answer of question	Partially correct the question	Wrong answer of questions	Not attempt the questions
1(b)	17	28	22	33
1(d)	22	23	35	20
1(e)	26	23	40	11
2(c)	21	18	35	26
2(e)	12	41	22	25
2(g)	10	27	33	20

Above table shows that the student's performance in angular value in trigonometry where poor in question no.1(b). Among 100 students, 17 students wrote correct answer properly.28 students wrote partially correct answer, 22 students wrote wrong answer and 33students didn't attempt this question. Similarly in question no.1(d). Among 100 students, 22 students wrote correct answer properly, 23 students wrote partially correct answer, 35 students wrote wrong answer and 11students didn't attempt this question. In question no.2(g) only 10 students wrote right answer, 27 students wrote partially correct answer,20 students didn't attempt this question related to angular value and other remaining students were partially attempt the question. In this research researcher found that student have lack of pre knowledge and concept about angular value.

In question no.1 (b) I asked the question that: Convert $14^0 9^{!}\ 50^{!!}$ into seconds. In this question students convert it multiply by 60 in each term second, minute and degree. But the correct answer is convert 14^0 in to second multiplying by $(140 \times 60 \times 60)$ and 9 minute is convert in to second by (9×60) and add with 50 second. Similarly in question no.1(c) students convert the degree in to radian by well process but in the related reverse condition in question no.3(d), 60 student are unable to solve this question. They gave the wrong answer of angular value. This shows that student had lack of conceptual knowledge about angular value. After found these difficulties I took interview with one that problematic student which is given below:

R: In your answer seat read question 1(b) and the solution that you write.

S_2: ok sir.....I finished

R: Why are you multiplying by 60 in degree only one time to convert second?

S_2: I know that it must be multiply by 60 to convert each other.

R: Is degree and minute are same?

S_2: I think no sir.

R: That's why, why do u multiply degree and minute by same number?

S_2: sir it needs to convert in second so I do this.

R: oh, convert 2 degree in minute.

S_2: um... $2 \times 60 = 120$.

R: Also convert it into second.

S: 120$\times\ 60 = 7200$

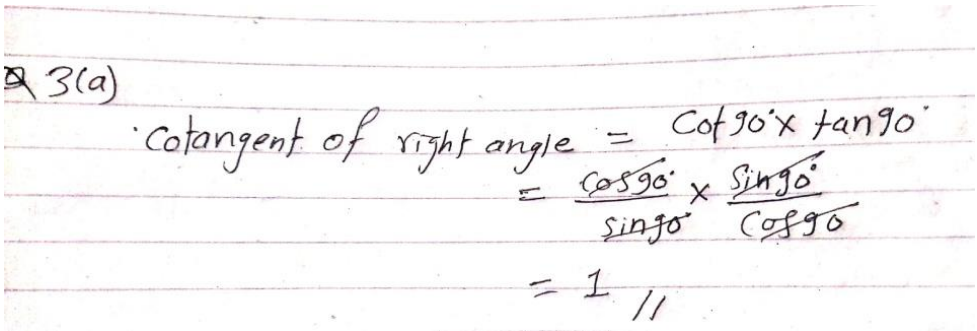
R: Why don't write this in question no.1(b)?

S_2: yes, I confuse to convert degree into second.

This shows that he had problem to define degree, minute and second. Also he had not knowledge about how to convert each term one to another. At the time of

interview he said that it must be multiply by 60 to convert degree, minute and second each other. But it must multiply by 60 only converting degree to minute and minute to second. This shows that student had misconception about converting angular value. In the next steps I asked him to convert degree to minute and similarly minute to second separately. He gave write answer of this question. But he had difficulties to convert directly from degree to second. This shows he had not good knowledge about relation of degree, minute and second. Similarly he had not proper idea to convert trigonometric value. So, He had not good concept about degree, minute and second.

In question no. 3(a) I gave the question to find the cotangent of right angle. In this question Only 25 students write the correct answers. Forty students didn't able to give right answer and 35 students didn't attempt this question. The representative picture of solution as follows:



In the above answer student was not gave correct answer of cotangent of right angle. This shows that student had difficulties in calculating angular value. Student wrote that, cotangent = cot90× tan90 = $\frac{\cos 90^0}{\sin 90^0} \times \frac{\sin 90^0}{\cos 90^0}$. After that student cut numerator and enumerator of same terms then he wrote answer as 1 which was wrong. This shows that student had lack of conceptual about cotangent. He had not good knowledge about mathematical term. It should be $\cot 90^0 = \frac{\cos 90^0}{\sin 90^0} = \frac{0}{1} = 0$. To

identify the student difficulties I took in-depth interview on the basis of above question which given as follows:

R: Do you know about cotangent?

S_3: Yes, It is the relation of cot and tan.

R: How do you say that?

S_3: sir, after separating cotangent we get it.

R: Do you have any idea about tangent?

S_3: I don't know sir.

Above response shows that students had not clear meaning of cotangent. At the time of interview he said that cotangent is the connected form of cot and tan which is wrong. This shows students had difficulties in representation of mathematical terms. Students had not conceptual knowledge about tangent. Also from written test I conclude that he had not proper skill to find cotangent. That's why students had incomplete understanding to compute the value of cotangent and difficulties in mathematical representation or symbolization. According to the Chirume (2012) most students fail to understand or interpret the meaning of mathematics symbols due to their taught to read, pronounce and use them.

Student's difficulties in finding trigonometric ratio. Trigonometric ratio is a ratio that describes a relationship between a side and angle of a triangle. Trigonometric ratios are sin, cos, tan and their reciprocals. Therefore, there are six trigonometric ratios in total. For example, sin is the ratio of perpendicular to hypotenuse. Trigonometric ratios are meaningful if they have some angle attached to them. Difficulties in trigonometric ratios is that the students feel problem in find the value of trigonometric ratio, inverse relation and problem to find perpendicular, base, hypotenuse. To determine the difficulties in trigonometric ratio I made five

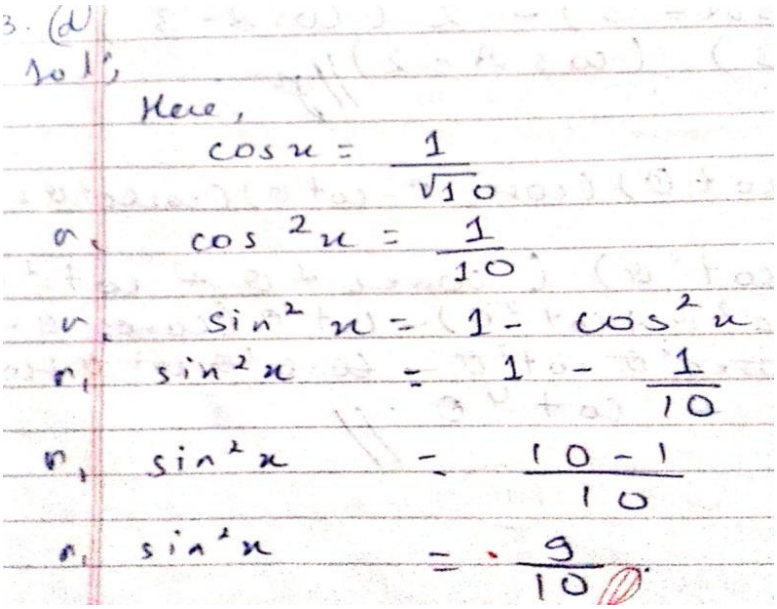
trigonometric questions for this. The performance of students in this domain is given below:

Question number	Correct answer of question	Partially solve the question	Wrong answer of questions	Not attempt the questions
2(d)	9	27	33	31
3(a)	14	24	26	36
3(b)	27	21	33	19
3(c)	35	30	22	13
3(d)	13	17	40	30

Above table shows that student had difficulties in trigonometric ratios. Among five related question only nine students were able to wrote right answer of question no.2 (d). thirty-three students were attempted this question but they cannot wrote right answer. Among 100 students 27 students were try to wrote this question but they didn't give complete answer. Similarly, most of the student confused in 3(a). Only 14 students wrote right answer of this question, 26 student attempts this question but they are unable to give complete answer, 36 students didn't attempt this question. In the mathematics achievement test 27 students wrote correct answer of question no 3(b). But in question number 3(d) only 13 students were able to solve it, 17 students wrote partial answer and 30 students didn't attempts this question.

In question no.3(d)I asked the question, If $\cos x = \frac{1}{\sqrt{10}}$ then prove that $\sec^2 x - \tan^2 x = 1$. In this question students confused to determine the remaining trigonometric

ratio to find the value of sec^2x and tan^2x Students didn't understand how to solve the ratio related problem. The sample of student performance is given below:



Problem solving requires knowledge of strategies. Students need techniques that will help them to develop plans for a solution (Polya1945).In the above problem student cannot decide how to solve this problem. Student had not understood the overall meaning of question and thus unable to proceed further. In this question student started alternative way to solving. He found the value of sin^2x and cos^2x but he had a problem to connect the trigonometric ratio of sec^2 x and tan^2 x, and to proved. It must had been find out sec^2 x and tan^2 x by using the trigonometric ratio as $sec^2x = \frac{1}{cos^2x}$ and $tan^2x = \frac{sin^2x}{cos^2x}$.After that putting this value in left hand side of question its give the same result of right hand side. But the student didn't decide to do. According to the polyas problems solving student had problem to carry out the plan, due to the lack of conceptual knowledge about trigonometric ratio. At the time of interview student said that:

R: What do you understand about sin x ratio?

S_4 sin x is p over h, where p is the length of the height of a right triangle and h is the length of the hypotenuse.

R: How do you get the ratio of tan x and sec x?

S_4 Um, tanx is found by sin x/cos x but I confused in sec x it may be cos x/sin x.

R: Why don't use this ratio in question no. 3(d)?

S_4: At that time I don't know this ratio.

R: Why choose this method to prove this question?

S_4:"I think it is easy from first given part of question, but I cannot decide what to do in the next steps of the solution."

After the mathematics achievement test and interview I found that student had difficulties to identified how to solve this question and how to connect trigonometric ratio from sinx, cosx to secx, tanx. At the time of interview student didn't gave the idea to find the ratio of secx. This shows that he rote sin, cos, tan and its relation .But he didn't decide how to find the ratio of secx by using cosx. At the same case I asked the question cosec θ will have the same sign as which other function? And why? In question number 2.(a) he gave the wrong answer of this question. He said that cos θ have same sign of cosec θ because both of this has either positive or negative sign as same time. This shows that he had not good concept about relation of sin, cos, tan and their reciprocals. This shows that he had difficulties to apply mathematical concept in trigonometric problem. According to Usman and Hussaini (2017) most of the students make error at the process skill level especially in the manipulation of trig ratios using formula. In the next steps he said that he didn't know the ratio related formula at exam time so he did alternative method.

Procedural Difficulties

Students have problems to reach correct answer because they are unable to recall basic math facts, procedures, rules, or formula. Student feels difficulty to remembering previously doing patterns and forgets what he or she is doing in the middle part of trigonometric problem and which leads to incorrect solutions. Schneider & Star (2015) is also indicate that procedural difficulties occurred when students failed to carry out manipulations or algorithms, even if concepts were understood and interpretation errors occurred when students wrongly interpreted a concept due to over-generalization of the existing schema. Students feel highly difficulties on these process skills, using trigonometric formula, calculation and operation of trigonometric problem. Procedural difficulties faced by students were categories in the following way:

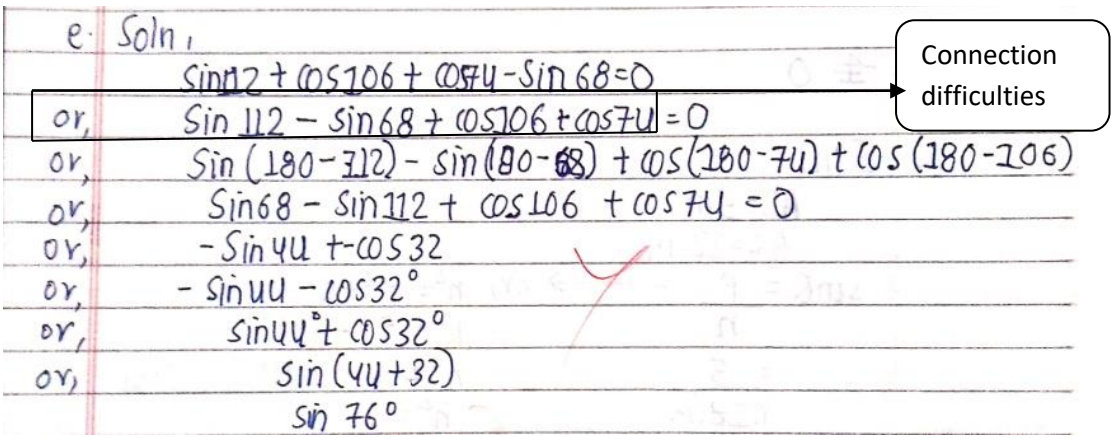
- Student's difficulties in way of problem solving
- Student's difficulties in using formula
- Student's difficulties in mathematical operation

Student's difficulties in way of problem solving. Difficulties in way of problem solving is that, the students cannot apply and to integrate any mathematical concepts, rules and skills as well as making decision, Ali &Desa (2004). Most of the students have difficulties in solving trigonometric problem because of their less practice, lack of problem solving skill and careless.

Polya's four stage of problem solving was used to determine the student's difficulties in problem solving. Polya's included the four steps of problem solving which are understand the problem, devise a plan, carry out the plan and looking back. These stages are sufficient to solve the trigonometric problem. But most of the student

does not have good understanding of problem and neither make plane. Most of the exercise of trigonometry in grade IX is related to problem solving. But only few students are able to solve the problem. I took diagnostics test to determine the student difficulties in trigonometric problem solving.

In question no. 2(g) I asked the question to Prove that: sin112+cos106+cos74-sin68=0. In this question Among 100 students only 12 students attempted this question without any mistake. Thirty-six students didn't attempt this question, 22 students were tried to solve this question but they didn't give complete answer and 30 give completely wrong answer. Due to the Lack of mathematics skills students feel difficulties in solving problem. If the students have not good idea about sequential process of problem he cannot meet the answer. Garderen (2006) also supported that students are required to apply and integrate many mathematical concepts and skills during the process of making decision and problem-solving. In the above question student had difficulties to identify the trigonometric value which is not easily found from tabular value. The sample of student test given below:



According to the Polya the first step of problem solving understands the problem. It involves identifying the key pieces of information needed to find the

answer. Students required reading the problem several time and putting the problem into their own word. The above response of the student shows that, he didn't understand the trigonometric values such as $\sin 112^0$, $\cos 106^0$, $\cos 74^0$, $\sin 68^0$ which is not easily find out from tabular value. Students had difficulties to connect the significant degree in $\sin 112^0$, $\cos 106^0$, $\cos 74^0$, $\sin 68^0$. He uses $\sin 112^o = \sin (180-112)^o$, $\sin 68^o = \sin (180-68)^0$ and so, to find $\sin 112^0$, $\cos 106^0$, $\cos 74^0$, $\sin 68^0$ which is wrong. It required connecting the significant degree such as 90^0 or 180^0 with sin and cos as $\sin 112^o = \sin (180-68)^o$, $\sin 106^o = \sin (180-74)^o$. This shows that student can't understand the problem well. He also can't make a plan and performing the plan well. Student didn't wrote what is given and what to do in the answer. Student didn't follow the structured of answer so, student was unable to solve above trigonometric problem. The following were interviews with the student

R: Can you give me an approximation of $\sin 45^0$ and $\sin 112^0$?

S_1: um, sin45 is $\frac{1}{\sqrt{2}}$ but I don't know sin112,

R: How do you know the value of sin45 and why don't write $\sin 112^0$?

S_1: I rote trigonometric tabular value until 180^0 but 112^0 is not there.

R: Is this impossible to find

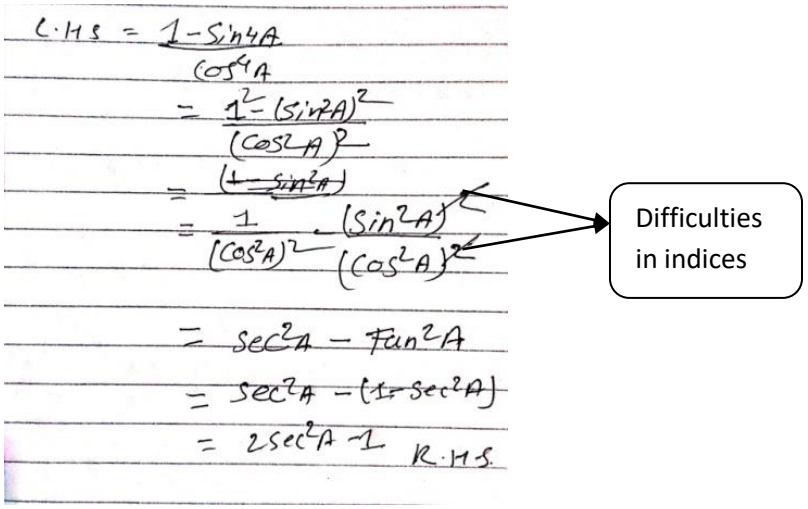
S_1: It is possible, but I always confused which significant value is used in these types of question.

According to the interview student had no confusion on tabular value. But he had problem to find non tabulated trigonometric values. At the time of interview student gave the correct answer of tabulated value. But he didn't gave the value of sin112 which is not a tabular value. This is because of rote learning. In the next steps he said that he had confusion to identifying the significant value for non tabulated

value like sin112, sin68 etc. This shows that he had difficulties in connection of significant value with given trigonometric value.

Above picture and interview shows that student had difficulties to find the trigonometric value except tabular value because of their rote learning. He had problem in connecting the given value with significant tabular value.

Similarly, I asked the question to prove $\frac{1-sin^4A}{cos^4A} = 2sec^2 - 1$in question no.4 (f).Out of 100 students only nine students were attempt this question without any mistake except them other had problem in the way of solving, 43 students didn't attempt this question, 20 students were tried to solve this question but they had difficulties in middle part of solution. So, they didn't give complete answer and 28 give completely wrong answer. Sample of the student performance is given below:



Above response of student shows that, she understands the problem and make a plan too, but she didn't solve the problem well. In this question student had difficulties in indices law in the third step she cut square without same base. Also she had problem in generalizing and using formula in third step. Student used wrong formula and used wrong way to solve this question because of lack of problem

solving skills. So, he mistake in every steps of solution. In this question student should do as

$$\frac{1-(sin^2A)^2}{(cos^2A)^2}=\frac{(1-sin^2A)(1+sin^2A)}{(cos^2A)^2}=\frac{cos^2(1+sin^2A)}{(cos^2A)^2}=\frac{1}{cos^2A}+\frac{sin^2A}{cos^2A}$$

$$= sec^2A + tan^2A = sec^2A + (sec^2A - 1) = 2sec^2A - 1$$

After checking the copy, I took the interview with student as following:

R: In your answer seat read question 4(f) and the solution that you write.

S_5: ok sir.....I finished

R: Explain each stage of your solution.

S_5: At first I convert the 1- sin^4A in to 1^2-$(sin^2)^2$ and cos^4A in to $(cos^2A)^2$ .Then separate each other....

R: why did you separate it?

S_5: It's a rule sir, when we separate this term it is easy to convert in formula.

R: What is the formula of $\frac{1}{(cos^2A)^2}$?

S_5: sec^2A

(Researcher explained the correct steps of solution then students realized his mistake)

S_5: oh I don't think this sir, I don't care the square.

R: Why you eliminate squire term of sinA and cosA in third stapes?

S_5: There is square term in denominator and numerator that's why they cut each other.

R: Do you have idea about indices law?

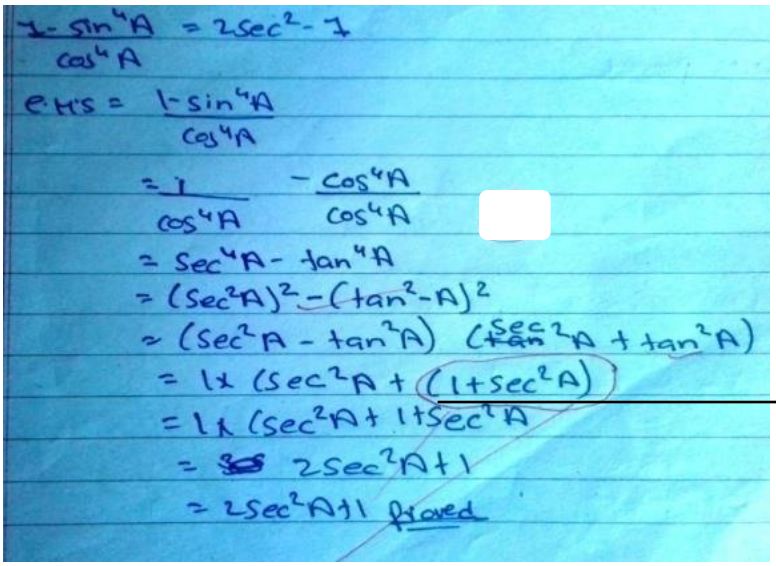
S_5: yes, it's says that the same power of denominator and numerator are cut each other.

Above figure and interview shows that she had problem in solving skills. Students could not see what was done in previous steps and what to do in next steps.

So she did not write correct answer in right process. This concludes that she had problem on carry out the plan. Student had lack of concept about indices rules. Also she had problem in separating and multiplying the power of trigonometric term. At the time of interview, she said that in third steps it is necessary to separate the term $\frac{1-(sin^2A)^2}{(cos^2A)^2}$,which leads wrong process. In this steps she should used the formula on $[1-(sin^2A)^2]$, this shows she had not good skill in solving problem. He had misconception to separating the term. After that I asked her why do you separate this term? Then she said that it's a rule. It's shows that she mistake in separating and using formula in proper place. According to the Orhun (2015) the performances of the student are confirmed that students' mistakes are made very systematically. This shows that many students had not developed clear concepts for trigonometry, and that some of them use algebraic notation as informal and inconsistent personal shorthand. The main reasons of students' mistakes are due to teaching method. Then after I asked her why do you eliminating square term in numerator and denominator? Then she point out that it is the law of indices. But she didn't follow the rules of indices.

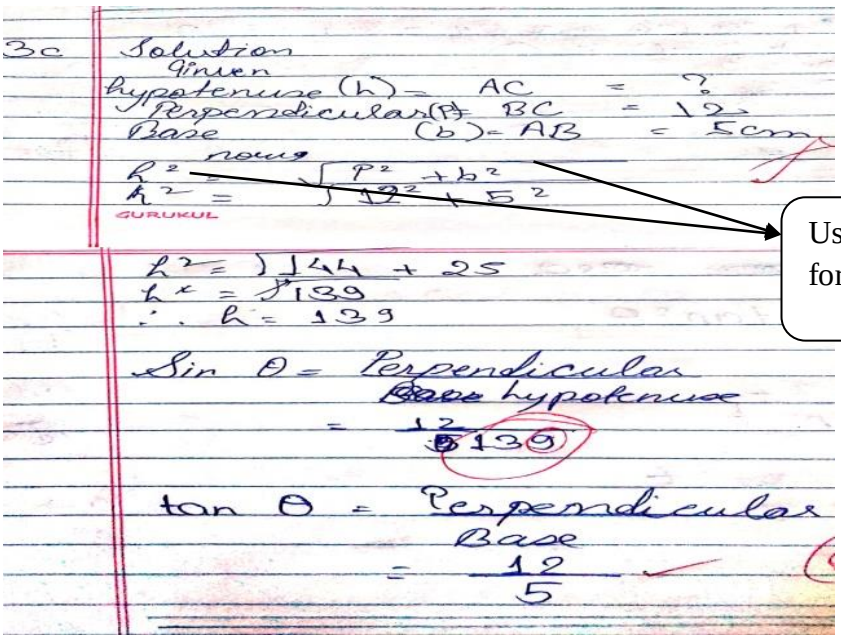
Student's difficulties in using formula. Students need to use pre knowledge and concept of problem to find the required solution. Most of the formula is derived from mathematical concept. So, to understand the trigonometric formula, it is necessary to know the trigonometric concept. There are various formulae developed in mathematics which helps to solve the trigonometric problem in easy way. Usman and Hussain (2017) are also supported that using a formula is a problem solving strategies that students used to find answers to trigonometry problem. To solve the problem students must choose the appropriate formula and substitute data in the correct places of a formula. To find the difficulties of student using formula, I took

the achievement test and interview. The performance of Student in using formula as given below:



From the result I found that students confused in using formula. In question no. 4(f) I asked to prove that: $\frac{1-sin^4A}{cos^4A} = 2sec^2 - 1$. In this question 40 students used wrong formula and 15 students stopped in that step where the formula is necessary. In this question, most of the students have applied $tan^2x = 1 - sec^2x$ but the formula should be $tan^2x = sec^2x - 1$. This shows that students didn't implement the correct formula. At the time of the interview, student said that he confused to write the correct formula in solving problem. After the diagnostics test and interview I concluded that, students failed to understand and describe what is required in the questions. So, he confused in choosing the correct formula to be used. Mensaha (2017) is also support that the error in process skill seems more pronounced in trigonometry because of using wrong formula. In the question no. 4(f), only nine Students wrote correct answer of the questions by well process. They understand the problem and make a planning and used proper formula too, and then they solve the problem well. But other student didn't it because of the confusing formula.

In question no.3(c) I asked that, in triangle ABC, AB (perpendicular) = 5cm, BC (base) = 12cm, find $\sin\theta$ and $\tan\theta$. In this question 35 students were able to solve without any mistake,30 students are try to write this question but they didn't give complete solution,22 students give wrong answer and 13 students didn't attempt this question. In this question most of the students feel difficulties to identify perpendicular, base and hypotenuse from figure. The sample of the student's performance is given below:



In the above performance, student decides how to solve this problem. But he had problem to identify perpendicular, base and hypotenuse from the figure. Student didn't understand the overall meaning of question and thus unable to solve further properly. This shows that he had problem on visualization of object. Also In this question he used $h^2 = \sqrt{p^2+b^2}$ to identify the hypotenuse which is wrong. It should be $h^2 = p^2 + b^2$. He had difficulties with relation of perpendicular, base and hypotenuse. In the first steps he wrote AB = base = 5 and BC = perpendicular = 12 which is wrong. This shows student had difficulties to identify the Pythagorean triples. I took the interview with student which is given as following:

R: In your answer seat read question 3(c) and the solution that you write.

S_6: ok sir.....I finished

R: How do you write base = 5 and perpendicular = 12 from figure?

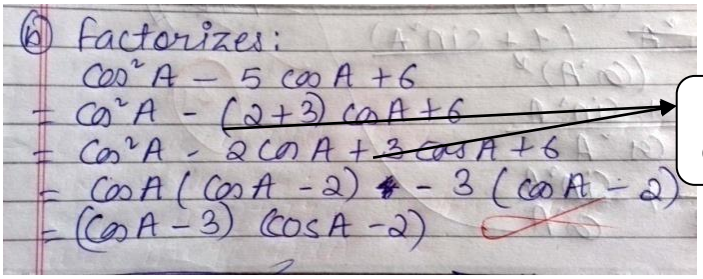
S_6: sir, in this right angle triangle, another angle is also given so the opposite side of this angle is always base so I write this.

R: What is Pythagorean relation?

S_6: umm... $h^2 = \sqrt{p^2+b^2}$.

Above response of student shows that students had difficulties in visualizing the objects. At the time of interview he said that, in right angle triangle if another angle is given then its opposite side is base, which is wrong. It should be perpendicular. This shows that he had difficulties in visualizing the triangle. According to the Van heles students has on first stages of geometrical learning. So, due to not visualizing the right angle triangle, he had difficulties in relation. In the next steps I asked him to say the relation of Pythagorean relation. But he gave wrong answer. Its shows that student had difficulties in making relation of perpendicular, base and hypotenuse. So, he didn't used proper formula in problem.

Student's difficulties in mathematical operation. Difficulties in mathematical operation are problem of student to operations the trigonometric expressions which are addition, subtraction, multiplication and division etc. This type of difficulties faces by students due to lack of problem solving skill, making wrong strategies. Polya (1945) also conclude that Problem solving requires knowledge of strategies and Students need techniques that will help them develop plans for a solution. The performance of students is given as follows:



Above question is related to question no.4 (b) In this question I asked, Factories: $\cos^2A-5\cos A+6$. In this question 30 students wrote correct answer. Twenty-two students didn't attempt this question and 15 students were wrote wrong answer. The above response of student shows that he can understand problem and can make a plan too, then he solve the problem but the student cannot meet the correct answer, he determine what is asked the question exactly but he mistake in calculation. Students confuse in sign (- , +) to factorized the trigonometric term. He wrote $\cos^2A-5\cos A+6 = \cos^2A-(2+3)\cos A+6 = \cos^2A-2\cos A+3\cos A+6 = \cos A(\cos A-2)-3(\cos A-2)$ which is wrong. In the third steps it should be $\cos^2A-2\cos A-3\cos A+6$.Similarly in forth step he took common by using negative sign with 3 which is also wrong.

The interview with student is given as following:

R: Look at your answer seat of question 4(b).

S_7: ok sir

R: How do you factorized in second steps?

S_7: sir, in this question we make adding form is 5 and multiplication form is 6 so I write 2+3.

R: Then after what do you do in next steps?

S_7: I open the brackets then and taking common then reach in answer.

R:What is the result of $(-) \times (+)$ *and* $(-) \times (-)$

S_7: it's both are + sir.

According to the interview student had knowledge how to factorized .But he had problem to used mathematical sign (+, -) in equation. This shows that student had difficulties in mathematical operation. K.N.E.C (2004) argues that the most glaring weakness is that of the learners' lack of knowledge in elementary techniques and their ignorance of simple algorithms and processes ... it is extremely worrying. Similarly, According to the Mensaha (2017) the students' error in solving trigonometry problems was due to their weaknesses in basic arithmetical operations.

Causes of Difficulties in Trigonometric problem solving

This study shows that students had both conceptual and procedural difficulty in trigonometric problem solving, which are important part of mathematics. In this fact, students have various problems in trigonometric solution. In this sense, this kind of conceptual and procedural difficulties that the students faced constitute a major causes to learning. There are number of reasons why the student having problems with trigonometry at school level. To find the causes of difficulties in trigonometry, I took in-depth interview of students and observed the selected school. The difficulty of learning trigonometry is not only caused by ineffective learning but may also be caused by students behaviors and there living environment. Dacey & Travers (2014) also conclude that psychosocial factor could influence the difficulties faced by students. After collecting the data the causes of poor performance in trigonometry among secondary level students are categorized as misconception of the trigonometry, pre-knowledge, home environment, school environment, motivation, which are interpreted individually as below:

Pre-knowledge

Before beginning any chapter or unit, it is essential to find out what the student's knowledge about the topic. What students know is difficult to predict without some sort of objective measure, especially considering the ranges of pre-knowledge in any one class. Pre-knowledge about trigonometry is the knowledge that the learner already has before they meet new information about trigonometry. A common problem faced by student in secondary level because their lack of pre-knowledge and skills. Pre-knowledge has long been considered as the most important factor influencing learning and student achievement. When the student enter more advanced courses in their curriculum. This is not only a challenge for students and instructors, but also an important issue in curriculum design.

Mathematics is abstract subject; it has many facts, theory, and other previous concept. Pre knowledge is the important factor to present grade. To determine the pre knowledge I took the diagnostics test and in-depth interview of student. From this result of achievement test and in-depth interview I found that most of the student had various difficulties in learning trigonometric problem. On the basis of this result I went to find the causes of those difficulties. For this I took in-depth interview with seven students who didn't gave correct answer in achievement test and I observed student's classroom. This helps to find the causes of difficulties in learning trigonometry. The student's views are given as follows

"I study trigonometry in previous class also, but In that time I didn't study trigonometry well and my parents as well as teacher didn't encourage to reading opt math. Now in grade nine opt math is compulsory but I don't interest in it."

This shows that student have not of interest in optional mathematics because of his lack of pre-knowledge. By the lack of motivation and encouragement of learning, student didn't feel mathematics is important in future life that's why she didn't focus optional math on previous class. Hence Pre knowledge is main causes of learning trigonometry which directly affect on student achievement of optional mathematics. According to the Nath (2002) previous knowledge of students played a significant effect on students on student's achievement in trigonometry.

Misconceptions on Learning Trigonometry

Misconceptions are one of the most affected factors on learning trigonometry. The problem that leads to very serious learning difficulties in trigonometry is misconceptions. Student faced this type of problem by previous inadequate teaching, informal thinking and poor remembrance. I took the mathematics achievement test, observation and interview to analyze the cause of misconception in trigonometry. Students can give wrong answer due to lack of knowledge, wrong information in the question or faulty thinking during the test, but these do not prove that student has misconceptions on that concept. Therefore, tests as well as other most appropriate ways to determine students' misconceptions are collecting qualitative data through interview and observation, since they provide in-depth information about students' knowledge.

In question no.3 (a) I asked to find cotangent of a right angle. In this question most of the students had confused to find it. One student write that cotangent of right angle is cot90 ×tan90 which was wrong. It should be cot90. This shows that students had misconception about cotangent. At the time of interview student said that:

"I thinks, cotangent is the connected form of cot and tan. So I confuse in this problem"

This shows that student have more confusion on trigonometric symbolization. In the above question student didn't care about the term cotangent. This is because of lack of practice, careless about notation and effective teaching method. According to the Baki (1999) Misconceptions emerge as a result of experiences and wrong beliefs of individual's .similarly Ay (2017) also point out that misconception is a kind of misunderstanding and misinterpretation which is derived from inaccurate meanings.

"I always confused in degree, minute and second. Teacher said that to convert degree, minute and second it must multiply by 60. So I did it."

Above view of students shows that he had misconception to convert degree, minute and second. He always multiplies by 60 to convert degree to second. Orhun (2015) also supported that the students had not developed clear concepts for trigonometry and that some of them use algebraic notation as informal and inconsistent personal shorthand and the main reasons of students' mistakes are due to teaching method. Students who have misconceptions in previous topics of mathematics can attach new misconceptions to the previous ones (Şandıret al.2007).

Impact of home/School Environment in Student's learning

Home is regarded as the first school of the all students. Home environment is the major factor to effects on learning and school performance, the mother's and father's education level had the most significant impact on a student to academic success. Similarly, parent's occupation, economic condition, size of family and other factor take the importance role for learning. That's why home environment is the major factor to affect the learning difficulties in school level students. In this study

some of the student's parents are illiterate so they were not helping their child and some are literate but they have not sufficient knowledge in mathematics. They didn't help their Childs to learning and solving trigonometry .That's why the student feels difficulties in learning trigonometry. In this study I took in-depth interview from students to find the family background and home environment. The student views that;

"*In school, teacher can teach any problem of trigonometry I feel understood and thought I can do but I forget how to solve in terms of problem at home. Also I have no any guidance in my home to help me in learning Trigonometry. So I feel trigonometry is difficulties for learning."*

From the above views of student it shows that, students did not well understand in trigonometric problem and they copied from the teacher but they cannot solve themselves in home alone. After taking interview and observed class room I conclude that the teacher were not conscious about their student's learning at classroom. Difficulties in trigonometry are caused by lack of practices of student at home and their illiterate parents. Acharya (2017) is also agreed that home is first school of child and mother is first teacher Good home environment enhances students' achievement in mathematics. Uneducated person unaware about the importance of mathematical knowledge in their life and they cannot force to learn mathematics to their child.

"I have not sufficient time at home because of my family condition. I must do work in vegetable shop with my mother. My family didn't focus on my study. So I feel trigonometry is difficulties."

From the above view of student I conclude that student had not sufficient learning opportunity because of the poor economic condition and family support. According to the student she didn't take sufficient time for learning trigonometry. Because of the she always work after and before school time with her mother. Karki (2018) is also found that in his thesis the home environment such as father's and mother's occupation, father's and mother's incomes, study materials, study time, household workload and parent's behaviors are the major factor on mathematics achievement of girls students.

Lack of Motivation

Motivation is the process of stimulating people to actions to accomplish the goals**.** Lack of proper motivation and guidance on methods of learning Mathematics and meta-cognitive and self-regulatory strategies are the main difficulty in learning mathematics. It is also very important for teachers to find how to motivate the student toward topics covered in the classroom. But one of the most difficult tasks for a teacher is determining whether a child's poor performance is due to a motivational or to a learning problem. Positive motivation stimulates the desirable behaviors on student. Positive attitude towards trigonometry play valuable role in learning trigonometric knowledge.

"*Teacher solved a problem in white board but he didn't focus what we understand or not. Teacher didn't care at last bench and he didn't encourage to solving trigonometric problem. So, I feel math is hard subject."*

From the above view of student I conclude that, teacher didn't care all students at class and didn't encourage the student to learning. I found that the teacher was unable to create proper motivation for problematic students. If the student were

motivated and not afraid of thinking about a problem they understand the problem easily. Trigonometry starts very basic and slow but introduces student to a new aspect of math and a lot more interesting one than school math.

"My parents and teachers always forced to do homework. Teacher didn't focus to practice mathematics at classroom. He always do math problem in white board and describe firstly which is meaning to us. So I cannot understand the mathematical problem."

Above views of student's shows that, most of the parents were uneducated. So, they always forced to do homework but never say practice mathematics. Similarly, teacher had not good experience for teaching mathematics.

Student Attitude/ Behaviors toward Mathematics

Attitude is either a positive or negative emotional disposition towards trigonometry. Most of students feel trigonometry is difficult topic and abstract concepts which results to students taking little interest in it. Due to this reason student's participation in learning is passive and inactive in classrooms. This study found that students attitudes was also negative in that most of them were fairly interested in trigonometry and not interested at optional mathematics. There have a close relationship between key features of motivation and attitudes towards mathematics. I had shown after observation the students didn't learn more effectively when they are not interested nor enjoy what they are learning. Similarly the relationship between math achievement and attitudes towards mathematics are consistent. The research concludes that good achievers develop more positive attitudes than lower achievers.

"I cannot understand the trigonometric terms and problem, there various confusing formula, so I cannot remember the proper formula to solving trigonometric problem that's why I fear to solve trigonometric problem."

This shows that he have fear from trigonometry. Because he always afraid in the time of solving problem. Student had lack of conceptual knowledge and he always confused to apply formula in problem. This is because of less practice at home, lack of confidence, motivation and anxiety that's why student have negative attitude toward trigonometry.

"I do not understand mathematics so in mathematics class I feel bored and I also not interested to solve any mathematical problems."

Above response of the student shows that due to not understanding the mathematical concept students feel difficulties and he also feel bored in mathematics. In this matter Joshi (2017) stated that when student didn't understand mathematical concept and hardly response to solve mathematical problem and also feel bored to attend class.

Classroom Observation

At the end of my first class observation, I conclude that pre-knowledge is building block for up-coming knowledge. Pre-knowledge plays the vital role for learning mathematics. In school (A) I observed the performance, behavior and classroom environment of students of grade IX. Teacher started the class with short poem which helps to motive the students. In this class new strategy and teaching materials do not used. In this class the teacher applied coordination or participation method for teaching. But it is not useful for these topics because of the laziness and lack of pre knowledge of students. At the time of problem solving teacher asks many

question about related topics which was related to previous class but students could not gave correct answer. In this situation most of the students seem passive. Students are confused in mathematical term, definition and how to solve the problem. This shows students had not proper previous knowledge. Mathematics is structural subject which is connected with previous formula, concepts and many other terms. So previous incomplete knowledge or wrong connection make difficulties in learning trigonometry.

My next observation was held in school (B). It was also optional mathematics class. Classroom was physically large in size with enough infrastructures. There were 29 students presented out of 32 students. In the class time I found that teacher was active in his sides and well prepared in the topic. But the class was mostly teacher centered. Teacher solves the problem in white board with explanation but he didn't care about students understanding. Similarly, it seems that students were not interested to learning; students are talking about outside of course, negligence to learning. But some of students were fully focused on teacher. In the 45 minute's time teacher didn't reach last bench and didn't used teaching material. This concludes that lack of teacher student's interaction, using insufficient had main causes to learning trigonometry. Yadab (2074) also conclude that lack of teaching material and teaching method affect to learning mathematics.

After observed classroom and interview with student I found that trigonometric concept is difficult in this level. This was clear indication students had negative attitude toward trigonometry. Students were busy in copying rather than thinking. They had not interest discussion about concept and problem solving. This meant many students had negative attitude towards the topic and hence affected their learning interest about the topic thus this was a major challenge. With proper

guidance, lack of student confidence level, mathematical anxiety, motivation and provision of necessary resources the attitude of students can be changed. In this line Joshi (2017) also agreed in his thesis most of the student have facing many problem in the time of learning mathematics so they had negative attitude toward mathematics this occur as by; lack of student confidence level, mathematical anxiety, lack of guardian's qualification, home environment, social cultural, social tradition, social discrimination, lack of trained teacher, lack of teaching material and due to other physical facility are the main factor that affecting student's attitude towards mathematics.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSION, RECOMMENDATION AND IMPLICATION

This chapter deals with the summary, major finding, concluding and recommendations.

Summary and Findings of the study

The main purpose of this study was to identify the learning difficulties in school level trigonometry and affected factors which involve creating difficulties in trigonometry. For this research, the difficulties were categories into two different parts: conceptual difficulties and procedural difficulties. Similarly affected factors were also categories into five different parts: Home environment, lack of pre knowledge, lack of motivation, Misconceptions and attitude towards trigonometry.

This study was a case study research design. The sample of study was taken in school level optional mathematics of grade nine on private school at Kaski district. The study area and respondents was selected by purposive sampling technique. I took achievement test, in-depth interview and class observation to fulfill the intended objective. I analyzed the data by general inductive approach. On the basis of data analysis and interpretation of result the findings were presented as follows:

Conceptual difficulties

- Most of the Students were confused in trigonometric notation.
- Due to not understanding angular value students faced difficulties.
- Students had difficulties in concept of cotangent.

- Students had difficulties in mathematical representation.
- Students faced difficulties to apply mathematical concept in trigonometric problem.

Procedural difficulties

- Student hadn't good skill to solving trigonometric problem as well as they were using wrong formula.
- Students had problem in connecting the given value with significant tabular value.
- Students had difficulties in understanding the problem, devising the plan, carry out the plan and looking back.
- Students had problem in separating and multiplying the power of trigonometric terms.
- Students faced difficulties in visualizing the objects. Due to not visualizing the right angle triangle, students had difficulties in relation of perpendicular, base and, hypotenuse.
- Students had difficulties in mathematical operation.

Causes of difficulties:

- There were difficulties in solving trigonometric problem due to lack of pre knowledge.
- Negative emotional expressions such as frustration and confusion were found to be more frequent amongst the unsuccessful problem solvers. They always confuse to using trigonometric formula.
- The serious problem of students was to the negative attitude toward trigonometry.
- Most of the parents were uneducated and they didn’t support their Childs at home. So, those students didn’t practice at home.
- Student had difficulties in solving trigonometric problem due to lack of motivation.

- There was lack of interaction between weak students and math's teacher, so the students didn't solve the trigonometric problem easily.
- Students do not have sufficient materials for learning mathematics.
- Problem on individual difference in learning trigonometry.

Conclusions

This research shows that students had difficulties in solving trigonometric problem. On the basis of findings I found that student had difficulties in mathematical representation, using appropriate formula, mathematical operation, connect the given trigonometric value with significant tabular value, to find trigonometric ratio and solving trigonometric problem. This qualitative analysis remarked that some causes for these difficulties. In conceptual difficulties, the reasons involved that lack of concentration, ignorance of mathematical definition, lack of motivation. Similarly in procedural difficulties the reason involve that lack of conceptual knowledge, less practice at home, lack of confidence, teaching method, student attitude towards trigonometry and the weakness of making connection between definition and problem. Student didn't give clear solution of trigonometric problem. Most of them were confusion on notation, forgetting the formula and careless in calculation. It is necessary to find suitable strategy to cover most of these difficulties for improving student's conceptual and procedural difficulties in trigonometry. The results of this analysis can help to select and design effectiveness learning strategy to rectify the mentioned difficulties.

Recommendation for Further Research

- This study was done in limitation and particular area of Kaski district, the broad and general study can be done for overall distinct.

- This type of research should be conducted different level and different subject in class.
- The further study should base on the topic "exploring difficulties on learning mathematical notation.

Recommendation for Educational Implication

It is clear from above discussion the less able students in trigonometry are likely to need special treatment. If this is not done, the students are likely to become progressively more confused and the student cannot survive in post-secondary mathematics programmers. The following list of strategies for education to implement in their practices:

- The teacher should use students centered method for teaching and his role as a facilitator.
- Students should be given enough opportunities to do regular trigonometric problem as this will support them to increasing their conceptual and procedural skills.
- School administration and curriculum designers helps to improving student's achievement and disruptive behavior during trigonometric problem solving and to improve learner's performance in mathematics.
- This study helps to identify the causes of student's difficulties in learning trigonometry, so this study might be help parents and teacher to reduce this cause.
- Learners should be given enough opportunities to do regular problem exercises as this increasing their reasoning skills

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Table of Content

APPENDIX-A

Mathematics Achievement Test

Attempt all Questions

Q.1) a. Define sexagesimal and centesimal system?

b. Convert $14^0 9^{!}\ 50^{!!}$ into seconds.

c. What is radian?

d. Convert 150^0 to radian measure.

e. The angle of triangle are $\left(\frac{7x}{2}\right)^g$, $\left(\frac{9x}{4}\right)^0$, $\left(\frac{\pi x}{50}\right)^c$.find the angle of triangle in degree.

Q.2) a. cosec θ will have the same sign as which other function? And why?

b. Which quadrant contains the terminal side of the angle $(-\frac{\pi^c}{5})$?

c. The value of $\sin(45^0+\theta)-\cos(45^0-\theta)$ is

i $2\cos\theta$ ii. $2\sin\theta$ iii.1 iv. 0

d. If the sin(x) = 3/2 in quadrant II, which of the following trigonometric value of the cos(x)?

i. $\frac{-\sqrt{55}}{8}$ ii. $\frac{\sqrt{55}}{8}$ iii. $\frac{-8}{\sqrt{55}}$ iv. $\frac{8}{\sqrt{55}}$

e. What is the complementary and Supplementary angle? Find Supplementary angle of 95^0

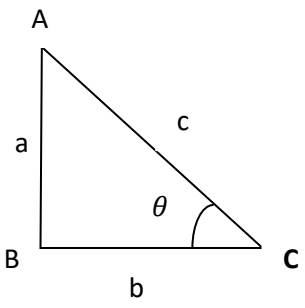
f. What is the value of $\sin(-\theta).\cos(90^0+\theta)+\cos(-\theta).\sin(90^0+\theta)$.

g. Prove that: sin112+cos106+cos74-sin68=0.

Q.3) a. **Find cotangent of a right angle.**

a. -1 b. 0
c. ½ d. -1/2

b. I. What trig ratio should be used to calculate either side a or c? From given figure.

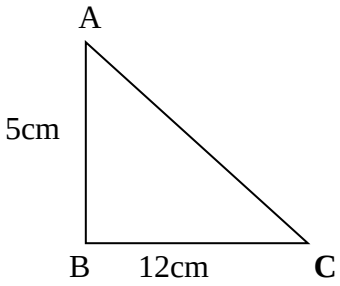


i.Sin θ
ii.Cos θ
iii.Tan θ

II. In the given figure, find the value of

trigonometric ratio sinθ,cosθ and cotθ.

c. In triangle ABC, AB=5cm, BC=12cm, find cotθ and tanθ



d. If cos x= $\frac{1}{\sqrt{10}}$ prove that $\sec^2 x - \tan^2 x = 1$

Q.4) a. Which one of the following is correct?

a. sinα × cosecα=2 b.$cot\theta = \frac{1}{ten\theta}$

c.$tan\theta = \frac{cos\theta}{sin\theta}$ d.$\sec^2\theta = 1 - \tan^2\theta$

b. Factories: $\cos^2 A - 5\cos A + 6$

c. Multiply$(\text{cosec}\theta + cot\theta)(\text{cosec}\theta - cot\theta)(\text{cosec}^2\theta + cot^2\theta)$.

d. Which one of the following is correct for sin t +$\frac{cos^2 t}{sint}$ =

a) sin t b) cosec t c) sec t d) cos t

e. Choose the correct option.

$9\,\text{cosec}^2 A - 9\,\cot^2 A =$

a) 1 b) 9 c) 8 d) 0

f. Prove that: $\frac{1-sin^4 A}{cos^4 A} = 2sec^2 - 1$

APPENDIX-B

Name of sample students selected for in-depth interview:

1. Santosh Subedi
2. Tulsi Sharma
3. Ramkrishna K.C.
4. Bikash Thapa
5. Krishna Paudel
6. Sabita Subidi
7. Anurag Gurung

APPENDIX-C

Interview Guideline with students

- On the basis of their solution test paper
- Personal interest
- Reading opportunity at home
- Discussion with teacher
- School environment for learning
- Learning activities
- Homework and class work
- Difficulties and cause in learning algebraic word problem
- Expectation with teacher, parents and school

APPINDIX-D

Interpretation the result of pilot test

The following table shows the students performance in test retest method

Number of students	1	2	3	4	5	6	7	8	9	10
Marks obtained from I test	30	15	18	5	38	18	12	35	22	21
Marks obtained from II test	31	15	17	9	34	38	14	30	17	23

To calculate correlation coefficient of above students marks by using following formula:

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X)^2}\sqrt{N\sum Y^2 - (\sum Y)^2}}$$

r = 0.76

According to the Garret (2008) the interpretation of reliability of coefficient is given below:

Coefficient	Nature
0.0 to ±o.2	Negligible
±o.2 to ±o.40	Present but slight
±o.40 to ±o.70	Substantial
±o.70 to ±o.1	Very high