PROBLEMS IN LEARNING GEOMETRIC THEOREMS IN SECONDARY SCHOOLS: A MIXED METHOD STUDY

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DECLARATION

I hereby declare that this dissertation has not been submitted earlier for the candidature for any other degree.

_____ January 24, 2021

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ABSTRACT

An abstract of the dissertation of *Sandip Dhungana* for the degree of *Master of Education in Mathematics Education* presented on January 24, 2021 at Kathmandu University School of Education. Title: *Problems in Learning Geometric Theorems in Secondary Schools: A Mixed Method Study*

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Theorems and their proofs are centred not only on Geometry but also on Mathematics education. The study of theorems and their proofs can create coherent reasoning and thinking aptitudes in Mathematics learners. The portion which is considered as a milestone of Geometry and overall Mathematics is being a matter of hurdle in Nepalese schools. The problem in learning Geometry theorems in secondary schools is not only decreasing the achievement of students in the examination but also reducing the students' interest in Mathematics. In my context, I have also experienced different types of difficulties in learning Geometry theorems both as a student and teacher. The abstract nature of theorems and its logical understanding were the major obstacles for me while learning. Therefore, the first purpose of this study was to measure the problems faced by the students in learning Geometry theorems at the secondary level and the second one was to investigate the reasons behind the problems.

The explanatory sequential mixed-method study was carried out to figure out the problems in learning Geometry theorems and their possible reasons. The study

was conducted in Tokha Municipality of Kathmandu district where 270 Grade IX and X students and 27 Mathematics teachers of the same level participated in the survey from seven different community high schools. Questionnaires with five-point Likert scales under five different headings (Content of Geometry, teaching-learning activities, school administration, teachers' professional development and evaluations techniques) were used as research tools for the survey which was analysed by using SPSS. The survey tool (structured questionnaire) was finalized after the pilot testing. Similarly, an interview was conducted to know the possible reasons behind the problems found in the first phase study. For the qualitative setting, two students of secondary level, two Mathematics teachers, an educationist, and a curriculum officer, who had spent their long time in the field of school Mathematics, were chosen. Both qualitative and quantitative data were collected through online mode in this study.

The analysis of students' responses collected through survey revealed that students felt Geometry theorems less practicable in their real-life; theoretical learning seemed more difficult than solving problems; teachers used fewer ICT tools in Mathematics, teachers hardly responded to all the students, and rarely focused on group works, and schools did not have the facility of Math lab and lack of internet access to clarify the concepts of Mathematics. From the students' responses, it was also found that there was no significant difference ($p > 0.05$) on the problems faced by the students based on their genders and found a significant difference ($p < 0.05$) in learning Geometry theorems based on their Grades. Additionally, correlation analysis was performed to see the relation between the different indicators (like content, school administration, teaching-learning materials, evaluation, and teacher's professional development) used in the survey tools. The correlation analysis of students' responses showed that there was slightly a positive correlation between the

problems in the content of Geometry and teaching-learning activity whereas problems in the content of Geometry had a weak positive correlation with evaluation technique and a moderate correlation between the problems in teaching-learning activity and school administration. The analysis also showed the moderate correlation between the problems in the teaching-learning activity and evaluation technique and moderate correlation between school administration and evaluation technique.

On the other hand, the analysis of teachers' responses indicated that students felt more complicated in learning Geometry theorems than other contents of Geometry and could not find the connections between the theorems. It was also found that the theorems were less connected to the students' daily practices as they were afraid of it. Moreover, they felt difficult to transfer the statements into the figures and prove them theoretically. Teachers' responses also showed that students were less interested in learning Geometry theorems and the majority of them left this section assuming that it does not affect their score. The poor foundation in school Mathematics, traditional algorithmic problem-solving approach of teaching and learning with rote memorization, few uses of manipulative in Geometry and inadequate training for the teachers in Geometry theorems were some of the problems discovered from the teachers' responses in learning Geometry theorems. It was also found that teachers' teaching experiences did not show any significant differences ($p > \alpha = 0.05$) in learning Geometry theorems for secondary students.

The qualitative section in this study concluded the study with the themes; the impact of teacher-students' relation in theorem learning, teaching-learning strategies in Geometry theorems, the internet and ICT tools in theorem learning, de-contextualization in Geometry learning and impact of teachers' training on Geometry

theorems learning which deals with the reasons behind the problems disclosed from the first phase study.

In this regard, this research study was oriented to explore the problems in learning Geometry theorems in Nepali Mathematics education, thereby giving an insight to the stakeholders of school mathematics to redesign an effective curriculum and teaching-learning activities.

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ABBREVIATIONS

+2	10 + 2 (Intermediate Level)
ANOVA	Analysis of Variance
CBS	Central Bureau of Statistics
CDC	Curriculum Development Centre
ERO	Education Review Office
ETC	Educational Training Centre
GPS	Global Positioning System
ICT	Information Communication Technology
M. Ed.	Master's in education
MOE	Ministry of Education
NASA	National Assessment of Students' Achievement
NCTM	Nation Council of Teachers' Mathematics
NEB	National Examinations Board
PBL	Project Based Learning
Ph. D	Doctor of Philosophy
PLC	Professional Learning Community
SEE	Secondary Education Examination
SLC	School Leaving Certificate
SPSS	Statistics Package for Social Science
TPD	Teachers Professional Development

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CHAPTER I

SETTING RESEARCH AGENDA

My Past as a Mathematics Learner

I am a University student doing mathematics education. To reach up to this level, I had faced many hurdles in the academic field. As a mathematics student, if I need to recall my experiences then I would share from my secondary level. Teaching and learning mathematics during my school days were quite different from the recent trends in Mathematics learning. The approaches of classroom pedagogy were different than modern approaches that include project-based learning (PBL), peer learning, collaborative learning, problem-solving approaches, etc. The traditional way of teaching mathematics as routine based problem solving, chalk duster activities and practising the mathematical problem many times for memorization were the main methods of my mathematics learning in my school education. My trend of learning mathematics was to get goods marks in examinations rather than making a clear concept of mathematics.

> *"Sandip you have to practice all the theorems many times so that you can memorize them which is the sure question for board exams to get good marks"*

This was one of the instructions of my mathematics teacher in my school. As far as I remember, I was a good performer in mathematics in my school as an algorithmic problem solver, but I found some misunderstanding in this subject from grade-IX. From this grade, I found some difficulties in understanding geometry theorems and their applications to solve other numerical problems. When I was studying at this level my teacher did not teach the geometry portion properly as

compared to other chapters in Mathematics. He taught us only the basic concepts and omitted most of the portion. We learned only seen theorems (experimental verifications and theoretical proof given in the textbooks) and short questions from the textbooks. We used to practice so-called important theorems many times as per the instruction of the teacher so that we could easily rewrite those in exams. Whenever we tried to solve different types of new theorems given in the last exercises of the chapter by taking teacher's support, he used to tell us, *"these are not so important and you cannot solve such problems also, these are not of your type"* so, he used to leave those questions. My concept on geometry was quite weaker than other portions, where I used to have an emphasis on memorization. Teachers used to rarely focus on those theorems in those days. Arriving here, I question; Why did they do so?

The Impact of System in School Education

> *"You shouldn't do these questions because these won't be asked in the exam. Rather than this, practice sure theorems which would be asked in the exam."*

This was one of the responses of my teacher in class IX whenever I asked him how to solve the extra theorems given at the last of the geometric exercise of the textbook. This reflects the trend of teaching mathematics at my school level. Here, I want to share my school education to depict how the system of teaching and assessment on mathematics was making difference in creating conceptual knowledge in geometry.

As there was a system of conducting exams at grade IX by the respective school or the same teacher who used to teach in the class, they might have found it easier not to teach us everything included in the textbook and from other practice books. There might be other reasons too but in my view, my teacher took advantage

of that system. Even though “The course of mathematics of secondary classes contains different portions by content and Geometry is one of them” (Akhter & Usmani, 2018, p. 46) in our school curriculum, and my relation with geometry was not much familiar in those days. I experienced a similar situation at my basic level too were my teachers rarely taught geometry. The situation was similar in other subjects too but I felt more uncomfortable to cope up with the content of Mathematics. I found each of the topics in mathematics is in sequential order from one grade to another in the school curriculum, so I might have felt difficulty in my secondary classes because of the poor foundation of geometry from my lower grades.

When I reached grade X, again I encountered the same chapter, geometry and I started to feel similar difficulties in this portion. Although I was a good performer (in terms of score in the test and exams) in my class, I used to feel difficulty to solve geometrical theorems. Now I can say that theoretical learning seemed difficult than problem-solving in Mathematics for me in those days. In those days, my math teacher tried to facilitate me and a few other students on those problems but he never focused more on difficult portions. He also used to tell that the portion was not for low achievers and to leave that even in the examination.

Until I appeared in the S.L.C. examination, I was unaware of the unseen theorems of geometry. Unseen theorems refer to those theorems which can be asked generally in grade IX and X board exams. Those theorems are newly formed by the question developers for the exam which are to be proved or solved by using various theorems and concepts of the respective curriculum of that particular grade or level. These unseen theorems were very famous in the previous SLC and even in the present SEE examinations which belong to higher ability questions. I was not able to solve that problem in my SLC exam as I had never solved such theorems before and also

never saw any of my friends or my teachers solving any unseen theorems in my classroom. I encountered different types of geometry problems in the exam hall which I had never experienced before. Since that time, I have felt geometry theorems as a big challenge for students and teachers because being a math teacher in the current scenario for the same level, I can say that if the theorems were easy to solve and teach then my teacher would teach on those days.

My Journey as a Mathematics Teacher

"You have got good marks in mathematics so you can teach mathematics well. If you are interested in teaching then I will provide an opportunity for you to teach at the secondary level."

After appearing in the 12th standard final exam, one of the private school's principals called me to teach mathematics in his school stating the aforementioned statement. I started my teaching career as a secondary math teacher from one of the districts in the eastern part of Nepal. Although I was only 19 years old at that time, I was the senior mathematics teacher in the school which had 1200 students. Initially, it was very challenging for me as I had to teach in an English medium but my schooling was Nepali medium. So, I faced language difficulties along with another difficulty "geometry theorems" like "*bhari mathi supari"* [translation: Overloaded] on those days. My teaching pedagogy was similar to my schooling where I felt easier for the other portions than teaching geometry.

I have been teaching mathematics for the secondary level for more than nine years, but still, I sometimes feel difficulties in teaching geometry theorems, especially the new ones. I have also found most of the students feeling the same. I tried to take views of some of my colleagues and friends in this regard, their problem is also the same. So, as an M.Ed. research project, I would like to undertake a study on the topic

"Problem in Learning Geometry Theorems in secondary schools" in Nepal. In my opinion, this level consists of basic theories in geometry theorems but if it is weak in the sense of concept and understanding development, it will be very difficult to bridge a gap between school and higher education Mathematics.

The place of mathematics in the life of any nation cannot be overemphasized because it is linked with the place of development in that nation. "Mathematics can be defined as the science of number and space and the language of science and technology" (Nwoke & Charles, 2016). It is necessary for the development of any nation and human beings to cope with the challenges of life. Martins (2013) argued mathematics as the queen and servant of school subjects since it cuts across the school curriculum. For me, mathematics is beyond someone's arguments and none of the disciplines of human life is separated from mathematics. The role of mathematics in the development of society from the pre-historic era to the present is very significant and still be more significant in the future (Makarfi, 2001). In this regard, I find mathematics as a platform for whole scientific and technological innovations. Mathematics is much more than theories and solving problems. It stands by the side of any creations of human civilization.

Geometry is one of the most important branches of mathematics education, which provides students with the ability of critical thinking, problem-solving and a better understanding of the other subjects of mathematics by giving students a high level of geometry thinking skills (Sahin, 2008) but it is giving many burdens to the school students. Similarly, "the study of geometry contributes in helping students to develop the skills of visualization, critical thinking, intuition, perspective, problem-solving, conjecturing, deductive reasoning, logical argument and proof" (Armah et al., 2017, p. 98). The place of geometry is quite large in mathematics education as it can

be related to people's real lives. The geometrical shapes and its concepts are everywhere in our context but our teaching and learning approach has failed to address the schools' classrooms and students' interest. On the other hand, I experienced that the theorem's proofs in Geometry are like choking learners' neck where the majority of the students start to feel anxiety with geometrical content in secondary classes. Hanna (2000) claims, "students cannot be said to have learned mathematics, or even about mathematics unless they have learned what proof is" (p. 24) but the abstractness and straight-forward methods of proving theorems are creating the problem in learning geometry theorems in secondary level schools of Nepal. In my opinion, the theorems given in the geometric sections are not enough matched with the level of the students and such theorems are creating fear in mathematics learners and demotivating them.

Statement of the Problem

The following subheadings are formulated and discussed to problematize the issue of this research study.

Performance in Mathematics (Mostly in Geometry)

Based on my experience as a teacher and a student, I have found that the geometry theorem is the most difficult section in the secondary level of Nepali mathematics curricula. Although geometry is a fundamental part of the Mathematics curriculum, a large number of students fail to develop an in-depth understanding of the basic concepts of geometry (Howse & Howse, 2014). I still remember my secondary level study when I found myself as a low achiever in this section although I was a good achiever in mathematics in my class.

Similarly, as a teacher, I have faced so many problems in this section. Firstly, the way of my teaching was similar to my teacher in the beginning days which led to

arise the similar problems for my students. I also found their competency weaker in Geometry than other portions of mathematics. At the beginning of my teaching whenever I encountered with a new theorem, I used to feel very difficult to prove them and still sometimes those theorems are challenging to me. Although geometry is a major portion of mathematics with its weightage nearly one-fourth parts of the evaluation in board examinations for Grade IX and X in our curriculum, I have experienced this section as highly abstract in the sense of developing concepts and creating the interest of adolescences. “If we look at our previous history of achievement of students in SLC and SEE particularly of mathematics subject, we can visualize our status of the mathematics education system in the school level and consequently it has still been devastating” (Manandhar, 2018, p. 20).

The low achievement in mathematics can be easily seen in the result of board exams like SLC/ SEE. According to the status result of MOE in SLC/ SEE examination in Mathematics, the low score is measured like; 22.46% of students score very low in 2009, 24.72% in 2010, 35.97% in 2011 and the data published in 2012 show that the percentage of the regular pass out students in mathematics was 52.71% and failure was 47.229%. Similarly, in 2013, the percentage of pass out students decreased by approximately 6% which became 47.1%; that means 52.90% of students failed in mathematics that year. In 2014, the percentage of failed students in mathematics increased by reaching 65%. Similarly, in 2015, about 70% of students failed in mathematics which shows that the percentage of failed students increased by approximately 5% in comparison to the previous year (MOE, 2012, 2013, 2014, & 2015). SLC result of 2016 was published in the GPA system and the performance in mathematics of students in this year does not seem good. The SLC report publish by MOE (2016) shows that 33.60% students have got ‘E’ Grade where 59.18% (E

=33.60%, D=13.40% & D+ =12.18%) are below D+ Grade and 30.03% (C =10.10%, C+ = 7.62%, B = 6.69% & B+ =5.62%) students are in C, C+, B and B+ Grades. Only 5.43% of students have got A and 5.35% have got A+ in Mathematics.

Likewise, the data provided by NEB in the achievement of students in mathematics in SEE exam shows that 28.53% students have got E Grade in 2017 where 56.42% (E =28.53%, D = 12.42%, D+ = 15.47%) are below D+ Grade. 34.87% (C = 11.48%, C+ = 8.27%, B = 6.85% and C+ = 8.27%) students are in C, C+, B and B+ Grades in the same year. In this year 5.30% students got A and 6.07% students got A+ Grade out of 462011 students. The SEE result of 2018 was also similar to the previous years. In 2018, 34.50% students achieved E Grade where 60.09% (E = 34.50%, D = 11.41%, D+ = 14.18%) are below D+ Grade and 32.31% (C = 11.16%, C+ = 8.28%, B = 6.95% and B+ = 5.92%) have got C. C+, B and B+ Grades. In this year, 5.18% students got A and 2.41% students got A+ Grade. Similarly, the SEE report published by NEB (2019) shows that 37.80% students got E Grade where 61.1% (E =37.80%, D =11.66% & D+ =11.64%) are below D+ Grade and 31.56% (C =9.75%, C+ =8.01%, B =7.35% & B+ =6.45%) students are in C, C+, B and B+ Grades in Mathematics. Only 4.91% got A and 2.42% got A+ Grades in Mathematics in the year. According to Educational Review Office (ERO) report (2019), the achievement in mathematics is minimum among the other subjects in secondary level. "The reason behind this pathetic situation might be the various myths related to Mathematics which have created fear, anxiety and consequently dropping out of mathematics" (Khanal, 2018, p. 15).

Foundation of Geometry in Lower Grades

The result published by ERO on students' achievement in Mathematics, Nepali and Social studies of grade VIII suggests that the majority of low performing

students in mathematics lies in the group of "a score of 20–25%, the medium-performing students 40– 50%, and the high-performing students as high as 70–80%. Of the content areas, the achievement is lower in Geometry (37%) and Sets (38%) than in the other areas (48–49%)" (Metsamuuronen & Kafle, 2013, p. xiv). This result also shows that only 37% of students, which is the least percentage in achievement is of Geometry and clears that students are performing very low in Geometry from the basic level. Similarly, Acharya, Metsamuuronen and Koirala (2013) also concluded in their study "The learning outcomes are weaker in Geometry and Sets than in other content areas" (p. 107).

Curriculum of Mathematics

Being a mathematics teacher for the same level, I have observed my students' different context in different time duration and have found a similar result as I experienced as a student. The obstacles in its language might be also another major problem that students are not able to diagnose that, what is given in the question and what they need to prove. As far as I have experienced, my students feel proving Geometry theorems more challenging than other contents of mathematics mostly at the secondary level. Very few students can understand the terminologies and statements of the theorem to be proved.

In grade X there are few theorems in our mathematics curriculum which are so-called seen theorems and seem very important theorems from the examination point of view but also students feel difficult to understand them and try to memorize them. As per my experience, the way of presenting the theorems in the curriculum of the secondary level is in conventional and creating anxiety in Mathematics learners. NCTM (2000) claims, "by the end of secondary school, students should be able to understand and produce mathematical proof – arguments consisting of logically

rigorous deduction of conclusion – and should be able to appreciate the value of such an argument" (p.55). As proving theorems in Geometry are necessary for creative and critical thinking skills, it can equip the students for their higher studies (Solaiman, Magno & Aman, 2017). But I have found that the school students in our context are not able to develop the reasoning capacity to make theorems learning easy. The majority of our students have failed to connect the logic between the mathematical statements, axioms, postulates, etc. and feel difficult to prove the theorems at the secondary level. The annual report of ERO concluded by Khanal and Pheyak (2018) shows that the performance in mathematics as well as in other subjects in our school education is not so satisfactory. As per my experience, only very few students can build up their potentiality to serve the geometry theorems and is a matter of hurdle for secondary level students in the school Mathematics curriculum.

Teaching-Learning Strategies

I have found my teaching practice more procedural than conceptual in Geometry theorems. I try to analyze each theorem while teaching in the classroom to make the students able to understand the particular problem so that they can prove it. But whenever they encountered a new theorem, they fail to prove it. This might be due to less practical implication of Geometry theorems inside our classrooms and beyond that in our context. Fitriyani, Widodo, and Hendroanto (2018) argued, "students' geometric thinking ability is low so they tend to avoid the courses" (p. 56). I (probably others) can give the conceptual understanding of the basic concepts of geometry in primary and middle school but it might be quite difficult to give the conceptual understanding of the theorems in secondary schools with our conventional approach of teaching-learning strategies.

In my experience, the performance of students in mathematics in our educational system is not satisfactory enough and this may have been because of various factors like teaching-learning strategies, evaluation system, teachers' professional development, competencies of teachers and administrative managements of institutions, etc. ERO performance audit report (2016) has described that the intuitional support for individual subject teaching and the collaboration between the subject teachers are very low. Due to the factor of institutional management and leadership, performance, competencies and achievement is decreasing in mathematics. NEB (2019) shows that performance in mathematics is minimum among all subjects in the SEE exam. The achievement of students decreasing which shows that our Mathematics learners either have less interest in learning Mathematics/ Geometry or there might be some problems in learning those areas in our context. In my opinion, one of the reasons behind this low achievement in Geometry could be our conventional approach of teaching-learning. In the personal conversion with Mr. K. C. (18th June 2020), who is one of the renowned mathematics teachers of Lalitpur district, argued that many teachers are not able to give the clear concept of geometry to students, which is producing mathematics anxiety among the learners. In this way, our traditional approach of teaching-learning Geometry might be a problem in learning Geometry theorems.

Image of Students and Teachers towards Proof and its Nature

The term "proof" is a 'terrifying word' for many of the students of this level. The National Council of Teachers of Mathematics (NCTM, 2000) states that proof is, "arguments consisting of logically rigorous deduction of conclusion from hypothesis" (p. 55). Similarly, Mingis and Grassl (1999) argued that proof is, "a collection of true statements linked together in a logical manner that serves as a convincing argument

for the truth of a mathematical statement" (p. 24). In this sense, I conclude proof as an "investigation using deductive reasoning" (Reid, 1995, p. 7). As per my experience, Both the teachers and students of Mathematics take the term 'proof' of theorem-pro as the most difficult section in secondary Mathematics. The psychological belief of a teacher, school, parents and more known people is that proof is only for the so-called talented students, which is creating fear and anxiety towards the Geometry theorems. Teachers select the students while teaching theorems in the class which demotivates the remaining learners in Mathematics learning and may create irritation towards the subject and subject teachers also can distract an ordinary learner from Mathematics learning.

There are many tastes in mathematics and geometry might be the bitter one for many students and very few people choose bitter things in their recipes. If it is the choice of anybody but still he/she does not take in large amount as compared to sweet things. The situation is similar in geometry. In this regard, Gunuc (2014) states, "lower academic score demonstrated poor class engagement" (p. 216). I agree with this statement and as a researcher, it is necessary to explore that to what extent and how students are engaged in learning mathematics. Perrin (2009) writes, "A primary way in which mathematics students develop reasoning skills by constructing mathematical proofs" (p. 341) but a large number of students do not prefer to learn or to prove the geometry theorems from mathematics. Likewise, among the so-called high achievers in mathematics also have very low interests in geometric theorems. I think the effort of teachers and students for this section is just to score marks in the examinations as they feel this is an unproductive area.

The above scenario shows that it is necessary to conduct a research study in this field to minimize the problems in learning geometry theorems and to improve the achievement of students in it.

Research Purpose

The purpose of this study was to explore the problems faced by the students in learning Geometry theorems at the secondary level in the first phase study and secondly, to investigate the reasons behind the problems identified from the first phase study.

Research Questions

The following research questions were formulated to meet the purpose of this study.

i. What are the problems in learning Geometry theorems at the secondary level?
ii. What factors are contributing for creating problems in learning Geometry theorems at the secondary level?

Statistical Hypotheses

The following six hypotheses have been formulated.

Hypothesis 1: There is no significant difference in the problem faced by the students in learning Geometry theorems according to their gender.

Hypothesis 2: There is no significant difference in the problem faced by the students in learning Geometry theorems according to their Grade.

Hypothesis 3: There is no relationship between problems in content and teaching-learning activities in geometry theorem at the secondary level.

Hypothesis 4: There is no relationship between problems in content of Geometry and evaluation techniques in Geometry theorems learning.

Hypothesis 5: There is no relationship between problems in teaching-learning activities and school administration in learning Geometry theorems.

Hypothesis 6: There is no relationship between problems in teaching-learning activities and evaluation techniques in learning Geometry theorems.

Hypothesis 7: There is no relationship between school administration and evaluation technique.

Hypothesis 8: There is no significant difference between the experiences of teachers on the problems in learning geometry theorems.

Rationale of the Study

"Proof in mathematics is a mean of validating, justifying, communicating, and systematizing Mathematical knowledge in all branches of mathematics" (Fraiser, 2003, p. 3). Such an important portion of Mathematics is creating problems in learning for the school students and found as a difficult section to learn in Mathematics. Therefore, this study has figure out the possible problems in learning Geometry theorems in the Nepali context and also identified the possible reason behind it.

The findings and exploration of this study may be helpful to make learners and teachers with the problems in learning Geometry theorems able to modify and design possible strategies which can minimize the problems in learning theorems. Similarly, this study can be beneficial for the curriculum designers to design a dynamic curriculum that can address the interest of 21st-century learners and make learner friendly curriculum to get the highest outcomes from it. On the other hand, this study may be valuable for those people, teachers, educators who want to see the significant changes in Mathematics education of Nepal.

Delimitation of the Research Study

The delimitations of my study are:

- This study is based on the factors like the content of Geometry, teaching-learning activities, school environment, evaluation system and teachers' professional development in learning geometry theorems.
- This study was conducted with the Grade IX and X students of Tokha Municipality of Kathmandu district.
- This study was conducted with the participants (students, teachers, educationists and curriculum designers) linked with Mathematics education in Nepal.

CHAPTER II

REVIEWING LITERATURE AND SETTING ARGUMENTS

In this section, I have reviewed various kinds of literature that help me in shaping my study in this form. It includes brief review literature related to the problem faced by the teachers and students in teaching and learning geometry. I had reviewed some articles, Journals and dissertations based on geometry teaching, theorems teaching and learning and simply geometry through different prospectives of the different contexts of secondary levels. As a researcher, the literature has guided me on my path to get my objectives. Similarly, I have presented this section into four subheadings as thematic review, theoretical review, empirical review and conceptual review.

Thematic Review

In this section, I have reviewed the literature related to my study which I have discussed in the following headings.

Learning Strategies of Geometry

Learning strategy is an approach or a technique through which he/she can complete the task. In my opinion, it is an individual practice in which a learner sets his/ her ways of learning concerning the environment where a learner is brought up. In this perspective Khanal (2015) states “Learning strategies are the actions employed by the students to learn, which enhance their performance” (p.34). Similarly, Schumaker and Deshler (2006) argued that learning techniques are related to ti how a student takes part in the task, including how an individual plan and controls his or her performance. Likewise, Ko (2002) argued that learning methodologies are cognitive

procedures, metacognitive procedures, techniques, socio-affective practices used to facilitate learning. The cognitive perspective refers to the mental map of the learner towards the subject matter and metacognitive prospectives to the "recognition of the learner's proficiency in a diverse social context with their tactics and techniques" (Khanal, 2015, p. 35). Similarly, "Socio-affective strategies strongly consider the student's relation to society as a whole ranging from family to the global community" (Zeynali et al., 2015, p. 10). In this sense, one can say that learning strategy is a way of gaining or creating knowledge in their perspectives. The learning strategies can differ from person to person and context to context.

In the case of Mathematics and particularly Geometry there can be many strategies and ways of learning it which I had discussed above. Wolters (1999) argued that mathematics learning strategies are often conscious practice or behaviours used by mathematics learners to enhance acquisition, storage, retention, recall, and use of new information. In the case of mathematics learning, I found that to learn or know the effective learning strategies is most important to learn mathematics. In case of my context, I realized that many of the teachers and learners are failed to grab the proper learning strategies in mathematics which lead "that the success level of geometry is low" (Serien, 2018, p. 132). As a result, mathematics and geometry are a nightmare for most of the students (Akın & Cancan, 2007).

Geometry, as one of the most significant parts of Mathematics, has a huge spot in education (Serin, 2018) and in our real life too. Most of the things that we mostly use and see in our environment around us have one kind of geometrical shape. Geometry is very closely related to the real world. We can use our geometrical thoughts and ideas in different types of works in our context like making artefacts, houses, temples and daily use materials. In my opinion, the use and design of such

materials and artefacts should be connected to our textbooks curriculum to have a better understanding of geometry. Geometry deals with the investigation of shapes and space which has an important role in developing students' critical thinking and problem-solving skills (Pesen, 2006). The connections of geometry to the daily practices shows that all types of learners are solving different kinds of geometrical issues in their real-life but failed to connect it to the classroom practices and found geometry as a difficult learning area in mathematics.

In my experience, Geometry has always been the monster of mathematics education to most of the students at the school level and higher. Additionally, geometry might be a factor that has been decreasing the number of mathematics interested students in schools. There can be a lot of students who are average or excellent in most of the topics and chapters of mathematics except geometry. In this situation, I feel like strategies used to teach and learn geometry might not be appropriate in our context. Being a student and a facilitator of the same area in different schools I too have found that my (probably other) concept of teaching geometry was just to solve the problems given in the textbooks. I used to focus more on the algorithmic problem solving rather than the conceptual understanding of the geometrical concepts. Mathematics education requires conceptual understanding and rigorous efforts in the creation of knowledge (Graven, 2002). Sometimes we try to relate our textbook statements to the real world but that also just in our words, students are not experiencing any ideas of geometry with the physical world themselves. The purpose of secondary level education is to develop critical thinking, problem-solving skills and learning to learn (Cano, 2005) but in my opinion, our system is failed to address these factors. As a teacher, I found that school students are failed to find the key concepts and connections between the axioms and terminologies

used in geometry and particularly theorems which creates misconceptions in it. In this scenario, Khanal (2015) argues that “effective learning requires students to take control over of their learning process and know-how, when, and where to use various learning strategies” (p.35) which is possible only when the learner can make the clear concepts in his/ her learning.

Geometry Theorems

“Proof and proving are central to geometry, just as they are central to mathematics” (Ding et al., 2015, p. 279). In my opinion, a theorem is a Math rule that has proof which goes along with it. In other words, a theorem is a statement that has become a rule because it has been proven to be true. These definitions can be clearer from our common example of theorem i.e., “Pythagoras Theorem” which is also considered as the most well-known theorem in mathematics. This theorem explains that ‘if you add together the square of the two legs of a right-angled triangle, you will get the square of the hypotenuse’ where the hypotenuse is a side of a right-angled triangle that is opposite to the right angle. Several Math theorems administer the guidelines of present-day mathematics. Nearly in each part of mathematics, there are various theorems established by eminent mathematicians around the globe. To think about a mathematical statement, a theorem requires verification. The proof affirms that the given numerical articulation is valid. Proving the theorems creates coherent reasoning and thinking aptitudes alongside staying away from Math errors. For any mathematics theorem, there is a built-up verification which legitimizes the truthfulness of the theorem statement.

“Among the various types of proofs in mathematics, proofs on geometric propositions are the most popular in secondary school syllabi” (Leung & Lee, 2017, p. 51). In the context of our curriculum, we can see most of the proofs are in the

geometry section. Whenever we hear the word “proof” we think of the geometry. We can see some theorems in the Trigonometry, Coordinate and Vector sections in additional mathematics of the secondary level too. Fujita, Jones and Yamamoto (2004) argue that while working in the proof of geometrical theorems, a student needs to develop their geometrical intuition, which is “a skill to create and manipulate geometrical figures in the mind, to see geometrical properties, to relate images to concepts and theorems in geometry, and decide where to start when solving problems in geometry” (p.5). The visualization of the concepts of the theorem, their diagrams and supportive ideas are very necessary for proving geometry theorems. The generic ideas and pre-formal design of proof can help to understand and design the proof (Leron & Zaslavsky, 2013). The word pre-formal here refers to the semi-structured design of the proof before designing the structural formal proof. We need to collect some ideas, axioms and other related theorems before designing a formal proof as a rough sketch which can be considered as pre-formal proof in proving theorems and has a very important role in proving geometry theorems. In this regard, Leung and Lee (2017) suggested, “pre-formal proof may serve as a stimulus or hint which eventfully leads to the complete structure of a formal proof”. Either a teacher or a learner needs to have at least an image of pre-formal proof which can be visualized in the cognition, however, “formal proofs remain essential in proving mathematical propositions and developing students’ advanced deductive reasoning capability” (Leung & Lee, 2017, p. 55). Stewart and Hadley (2014) stated that intense visualization abilities inclined to positively relate with pedagogical mathematics content knowledge in geometry.

In my opinion, the stage of geometry theorems in secondary schools of Nepal and their proving style is straight forward in nature. As a student when I was in the

same level, I used to hear "*no need to understand the theorem, you need to learn it, memorize these many theorems you will get one in the examination, this is a sure theorem for this time; memorize it, etc…*" from my teachers. So, I did the same to my students in the initial stage of my teaching career and continued up to 5/6 years. While reading through different researches and kinds of literature like Rohnman and Retnowati (2018); Jones and Tzekaki (2016); Ding et al. (2015); Serin (2018); Feza and Webb (2016), etc. I found that geometry and theorems in mathematics can be taught and learnt by using newly formed techniques (so-called modern techniques) and strategies suggested by the researches. As a researcher and a teacher of secondary level Maths, I have also felt, "We need to find ways, through research and classroom experience, to help students master the skills and the understanding they need" (Hanna, 2007, p. 15) and also suggest that mathematical proof has increasingly played a less prominent role in secondary Mathematics. Herbst (2002) argues that an adjustment in how students see proofs would require more than minor changes or calls for change in our current practices of teaching and learning. For this, the role of a teacher (belief and behaviour) might be very important to shape the students' proof of schemes (Harel & Sowder, 2007) and can impact on students' reactions in math thinking (Küchemann & Hoyles, 2001b; Diezmann et al., 2002).

Meaningful Learning of Mathematics

Learning is the acquisition and application of knowledge. The acquisition is the assimilation of knowledge. Application is the use of knowledge in the real world. According to Mayer (2002), the promotion of retention and the promotion of transfer are the two most important educational goals. Retention is the ability to recall the learned material in the future and transfer is the ability to use the learned concepts, ideas, formulas etc. to answer new questions, to solve new problems or facilitate new

subject matter (Mayer & Wittrock, 1996). Bransford, Brown and Cocking (1999) mentioned that in retention students simply remember what they have learned, whereas in transfer students not only remember but make sense of it and be able to use it. Remembering is the mental action and transfer is the action done in the real world whose effect can be seen. Mayer (2002) claimed that when the promotion of retention and transfer occurs in any learning, the learning becomes meaningful. To make mathematics learning meaningful, learners must develop the retention capability for the learned mathematical ideas and formulas and should be able to use them to solve the problems of the real world.

Ausubel (1963) mentioned four types of learning: rote learning, meaningful learning, reception learning and discovery learning. Rote learning is the memorization of facts, figures, symbols and formulas by repetition without understanding the core concept. Generally, rote learning is done at the beginning of the education to read letters. In mathematics, many learners learn the multiplication table, some mathematical symbols and even formulas by rote. In some cases, we need to apply rote learning, but it is a weak form of learning. Rote learning should be supported by meaningful learning. In meaningful learning, learners must relate new knowledge to relevant concepts they already know. Meaningful learning is the continuum of rote learning. Meaningful learning requires well-organized knowledge structure, emotional commitment to integrating new with existing knowledge and conceptually clear subject matter. Reception learning can be done in both rote and meaningful way. For example, a learner can store formulas of antiderivative without understanding the real meaning of antiderivative. This is the reception learning as rote. On the other hand, if the learner understands antiderivative as the reverse process of the derivative. He/she understands the detail process of formula formation process and stores in the brain by

acquiring the capacity of future use, then this is the reception learning in a meaningful way. Discovery learning is the student-centred learning where active learner explores the new ideas and concepts in a meaningful way.

Ausubel (1963) advocates for the use of advance organizer as a mechanism to help link new learning materials with existing related ideas. The advance organizers are separable into two categories as expository organizers and comparative organizers. Expository organizers provide new knowledge that is unfamiliar to the work. Comparative organizer integrates new concepts by discriminating between new and existing ideas. Meaningful learning consists of concept formation, concept assimilation and propositional learning. In geometry, congruency and similarity are two different concepts. In the concept formation, a learner tries to understand their meaning, symbols and properties. Concepts of congruency and similarity are learned in concept assimilation. Prepositional learning is the ability of the learner to apply the concept of congruency and similarity in the unseen theorems.

Meaningful learning refers to knowledge that has value to the learner, knowledge that satisfies, can be used, and which the learner can identify by incorporating into their thinking, feeling or doing. Moreover, it can be said that meaningful learning is to feel that all the pieces of concepts, ideas, theories, formulas, or arguments fit together (Ausbel-2018). According to Jonassen and Strobel (2006), the characteristics of meaningful learning are active, social, collaborative, intentional and authentic. Active learning refers to learning by doing. Meaningful learning is an interactive activity with the use of manipulative by the learner alone or with peers to generate new knowledge. Active learning should be supported by constructive learning. In constructive learning, the learner reflects on his/her learning and articulates what he/she has done or observed. Active learning enhances learning by

integrating new knowledge with prior knowledge. According to Vygotsky (I978), meaningful learning takes place in a social setting as a human is a social creature. According to him, it is natural for learners to communicate and collaborate. Collaboration increases conversation which ultimately increases learning, knowledge building and meaning-making of the world. According to Schank (1994), most human behaviour is goal-directed. Goal-directed learning is a pre-requisite for meaningful learning. Learners think and learn more when they have to fulfil an intention. Therefore, intention increases motivation, and learning becomes purposeful and self-regulating. Authenticity is the most important characteristics of meaningful learning. In schools, learning is based on some principles and theories. Connecting these principles and theories with the context, the learning can be made meaningful.

Geometry is an integral part of mathematics that is concerned with points, straight line, plane figures, space, spatial figures, and the relation between them (Biber, Tuna & Korkmaz, 2013). Geometrical knowledge is used to describe, analyze and understand the world in which we live (Zuya & Kwalat, 2015). In my school days, I enjoyed arithmetic and algebra, but the geometry was a headache for me. I had difficulties in geometric language comprehension. The figures used in the geometry were like puzzles for me. I could hardly memorize the seen geometric theorems by rote learning and unseen theorems were nightmares for me. When I reflect on my learning at that time, I realize that my geometry learning was not meaningful.

After the completion of the SLC examination, I got an opportunity to teach mathematics. Since then, I have been continuously teaching mathematics. It has been more than seven years. Most of the students thought geometry is a boring and difficult part of mathematics (Sah, 2016). In my own experience as well, I have found the majority of students not being able to learn geometry meaningfully. There could be

various reasons and issues. Some of the reasons are teachers' methods of instruction, geometric language, visualizing abilities (Noraini, 2006; Aysen, 2012, as cited in Fabiyi, 2017). According to Fabiyi (2017), the other factors which make geometry difficult and less meaningful are the absence of teaching materials, insufficient teaching time, inadequate school curriculum, poor reasoning skills and lack of proof by students. In the context of Nepal, Luitel (1999) has pointed out emphasis on learning geometry, contextualization of learning geometry and change from traditional one-way classroom to two-way interactive one as the three major issues to make geometric learning meaningful.

Regarding the emphasis on geometry learning, (CDC, 1999) has included four aspects. They are knowledge, application, problem solving and comprehension. In the knowledge section, students are expected to know definitions, facts and formulas. The application section expects students to be able to transfer the use of geometrical knowledge in the new situation. In problem-solving, the curriculum has expected that students will be capable of using geometry to solve their day-to-day problems. The aim of the comprehension section is on developing strong geometric concepts, their relationships and structure. If we compare these four aspects with the Blooms taxonomy, they all fall in the lower order thinking skills. It seems that CDC (1999) has not given importance to the higher-order thinking skills in the case of geometry learning. In such a scenario, how can the meaningful learning of geometry be expected? Luitel (1999) argued that the geometry curriculum has not given much emphasis on communication and spatial reasoning. It helps boost the geometrical reasoning. Spatial reasoning is the reasoning which is helpful in visualization, drawing and understanding of plane and solid geometry including maps and coordinates (Lindquest & Clements, 2001).

Contextualization is the teaching of the content by connecting to the real-life situation. In the case of Nepal, most of the geometry teaching is based on textbooks (Luitel, 1999). These textbooks are written in Nepali or English language. Nepal is a country with 125 ethnicity and 123 mother tongues (CBS, National Census, 2011). Due to the language barrier, many teachers and students feel difficulties in contextualizing the geometry. Not only that but also many mathematics teachers of Nepal are from the non-education backgrounds and they are unaware of contextualization. Before joining M. Ed. in mathematics education, I was also unknown about contextualization. So, still in Nepal teaching and learning of geometry is happening only from textbooks without the use of teaching materials and connecting to the real-life context.

Most of the Nepalese classrooms are crowded with more than fifty students. The length of the mathematics class is only forty minutes. In the limited time of forty minutes, teachers are compelled to follow the traditional one-way teaching approach. Students have to listen and copy the ideas and knowledge delivered by the teachers inside the classroom. Students get less chance to interact with the teacher and peers which is also a reason for making geometric learning less meaningful.

In my opinion, the way of teaching geometry in my context is more procedural and follows the algorithmic stepwise solving method. Rittle- Johnson et al. (2001) argued, “Procedural knowledge is the ability to execute action sequences to solve problems. This type of knowledge is tied to specific problem types and therefore is not widely generalizable (p.1)” in my context on those days the way of mathematics teaching and learning was highly guided by this approach. Why did we teach only the concrete steps of solving problems? Most of the students try to connect the relationship between the steps one after another in theorems proving. I have found

that the teaching/learning of geometry theorems is less conceptual. Hiebert and Lifevre (1986) argued in this concept as, “A knowledge that is reached in relationship. It can be taught as a connective web of knowledge, a network in which the linking relationships are as prominent as the discrete pieces of information which are linked to some network (p. 3-4)”. In his view, the conceptual knowledge can be connected with real information or to the real world. This can show the relationship between the abstract things to the practical behaviour of human being as far as possible. Students are memorizing the theorems, just to score grades in any examinations. The concept of teacher, student and parents, as far as I know, is only marks/grades oriented at the school level. In this sense, I can say that the teaching and learning of geometry theorems are less meaningful in our context.

I have already discussed why teaching and learning geometry is less meaningful in our context. To make it more meaningful, we should give less priority to rote learning. Geometry learning should focus on retention and transfer. The traditional one-way teacher-centric learning should be converted to two-way interactive student-centric teaching. Contextualization and integration of technology would be helpful.

Infected Geometry

Geometry is a branch of mathematics that is related to the study of points, lines, symmetries, shapes and patterns in the plane as well as in space. Geometry is everywhere around us. We find the beautiful geometrical patterns in leaves and flowers. The furs of animals like tigers, zebras, leopards etc., consist of attractive geometrical patterns. Birds like peacock and Lophophorus have mesmerizing geometrical patterns in their feather. The bodies of aquatic animals are symmetric and streamlined. If we analyze the honeycomb, we find the hexagonal shape. According to

Ozerem (2012), geometry study allows students to analyze and interpret the world they live in as well as equip them with the tools they can apply in other areas of mathematics. People have used the geometry of nature in arts, science and technology. Painting is one form of art where the artist needs to have a basic understanding of lines, shapes, knowledge about spatial concepts, patterns and tessellations. In sculpture designing, an artist uses the concept of three-dimensional geometry. Knowledge is extensively used in architecture and engineering. Geometry is used in astronomy to studying the position and motion of celestial bodies. Maps are used in survey and navigation. The global positioning system (GPS) is based on coordinate geometry. Even in a sport, geometry is used. For example, the football ground is rectangular. The middle part of the football ground consists of a circle with a centre. Its D-area consists of arcs. The four corners also consist of small arcs. The courts of tennis cannot be made without knowledge of geometry and measurements. In the cricket, both the bowler and batsman use the sense of angle for the best result. From some of these examples, it can be said that geometry is in our surrounding environment, so, we need to study it to make our life better. Clements and Battista (1992) have also acknowledged geometry as a tool to facilitate the interpretation and reflection of the physical environment.

Geometry is one of the beautiful subjects but it has infected our school level maths education due to various factors. In my opinion, some of the prominent factors are conventional teaching approach, rote learning, reproduction of geometry, unhealthy competition for marks/grades and lack of integration of technology.

According to Panthi and Belbase (2017), Nepalese mathematics teachers mostly apply the traditional teaching pedagogy such as lecture method and transmission approach. Students seem passive listeners and copiers. We focus only on

the cogitative domain of any student in the learning process. The cognitive domain involves knowledge and the development of intellectual skills in the mind-set. "Knowledge can be assessed by straight forward means" (Adams, 2015). This includes the recall or recognition of specific facts, procedural patterns, and concepts that serve in the development of intellectual abilities and skills. We have less habit of analyzing the concept of a learner in any topic/ discipline. There could be various reasons for following the traditional approach for teaching by mathematics teachers. The first reasons could be the classroom size. Most of the classrooms of Nepal are rectangular with two rows of benches and a black/whiteboard mounted on the wall. Four /five students sit on a single bench and about fifty to sixty students read in the same classroom. The second reason could be the lack of sufficient budget. Due to the limited budget, many schools are not in a condition to purchase readymade mathematics materials. Teachers also seem unwilling to use local and handmade materials. The third reason could be the lack of proper teacher training and motivation that encourages teachers to adopt modern student-centric approaches in geometry teaching.

Rote learning is the learning method in which students learn information by memorizing that information (Ishartono et al., 2019). Rote learning might help memorize spellings, date and time and some definitions in other subjects, but in mathematics, each and everything should be read by the conceptual understanding. Quirk (2000) claims that mathematics requires mastery of concepts rather than memorizing concepts. Memorized concepts are volatile and they work only for short time. Rote learning is not fruitful for cognitive development.

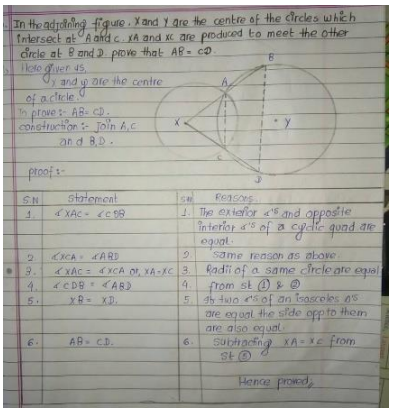

Figure 1: Sample of theorem proof

For example, many students memorize the statement “Opposite angles of a cyclic quadrilateral are supplementary”. Instead of just memorizing this statement, if students prove the theorem practically and then theoretically, then they can master the concepts and they need not force their brain to rote the statement.

The word reproduction means a lot in my profession. As a mathematics teacher, I have found myself as a reflecting agent on the curriculum images in a linear way. Reproduction refers to produce a new one of the same kind and here it refers to the repetition of the same knowledge in my context without any changes or creation. I have been solving the theorem alongside the figure from the beginning days of my teaching career without changing even a single step. Many other such theorems are imprinted in my mind and can prove them without using any logic, just like reciting them. From my own experience, I feel that I still search the same pattern and the algorithms and follow the same strategies in my classroom through which I was taught. Although I have learned so many things after that level (Grade IX and X) and I am in the process of transforming myself from conventional teacher to collaborative teacher, my experience of that level as a student still guides me. I teach the same content similarly as I learned. I have found my approach of delivering in the mathematics classroom as “Teaching as a transmission of knowledge” (Pant, 2017,

p.16). The ways of solving numerical and proving theorems are the same. All teachers were students in their past for the same level so, still, I (probably others) am using the same sentences and the words in proving the theorems. Nothing has been changed in this long time. Everything is rigid like water in a pond and producing knowledge of the same kind which can be considered as the reproduction of geometry. In this regard, Battista and Clements (1995) argued "a development sequence of reproducing Geometry figures focusing on memory, transformation involving rotation and visual perspective-taking". This implies that the learning of Geometry is not conceptual but a procedural or memorizing type. The situation of geometry learning in our context is also the same and the teaching practice is still conventional. "The reproductionist view promotes the replication of the same culture assuming that culture is an unchanging structure separated from individuals" (Pant, 2017, p.17). I have found many of the mathematics teachers reproducing the same knowledge similarly the way they learned. Unless we as mathematics teachers cannot transform ourselves from this procedural approach to a constructive approach, the learning of mathematics cannot be conceptual and the same is applied in geometry as an organ of mathematics.

Another factor for infection of geometry could be unhealthy competition for marks/ grades in any student. Teachers, parents and the whole society value the high scorers. Parents want to see good grades in the mark sheets of their children. Even after the SLC/SEE, many +2 colleges admit students by looking at their grades. Low scorers can not get admission in the desired college and the desired stream. The system has compelled students and teachers to focus on marks oriented study in which both the teachers and students are motivated towards the *parrot learning* (translation: learning without understanding). In this sense, students are memorizing the text like a

tape recorder and in my view, well-trained candidates are produced from our schools rather than well educated.

Mainali and Heck (2017) have felt that a teacher-centred, examination-driven teaching approach focuses on knowledge of facts and standard methods through drill and practice without the integration of ICT, is dominant in Nepalese high schools. Geometry learning can be made easy and interesting by using ICT tools. Dahal, Shrestha and Pant (2019) argue that technology is a powerful resource for learning and teaching mathematics and very helpful for engaging students in meaningful learning. They further argue software like GeoGebra, Google Sketch Up, and Sketch Pad, etc. are becoming useful to improve and enhance teaching and learning mathematics by giving better visualization effect. Due to the inaccessibility of technological accessories, and internet access, mathematics teachers are integrating technology at a low amount in teaching Geometry. As a result, Geometry teaching is mostly done by "Chalk and Talk" approach which is making beautiful geometry ugly in the eyes of students and it seems infected.

Math Phobia

The anxiety of mathematics is very high in my experience. I have found that very few students are interested in math and the rest of the others are not interested in school level mathematics. Olaniyan et al. (2015) argued that the mathematical weakness in students that deals with the psychological dimension of learning. Okigbo (2010) argued that phobia is an academic sickness whose virus has not yet been fully diagnosed for effective treatment in the class and the symptoms of this phobia are usually expressed on the faces of mathematics students in their classes. This phobia is spreading widely and many more students are infected through this phobia. To overcome this phobia, we teachers can play a model role as a doctor. In my point of

view, we can change our teaching approach from procedural to conceptual and the curriculum from teacher-centred to learner-centred.

For me, the main focus behind this phobia could be teachers, schools, parents and society. We as a teacher tell our students "Math is a difficult subject, labour hard on it",

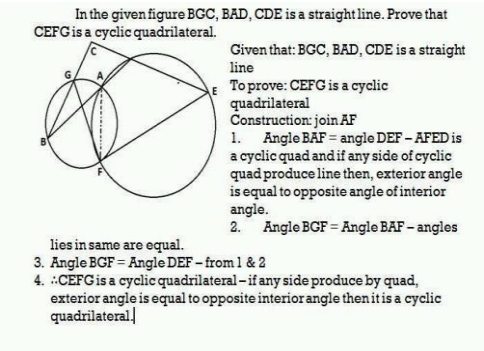

Figure 2: Sample of theorem proof

from their young age and all factors above repeat the same statement again and again. It is a terrible response to the learner and it causes frequent serve and intense anxiety (Tillfors, 2003). In this sense, "Mathematics phobia can be defined as a feeling of anxiety that hinders one from efficiently tackling mathematical problems" (Nwoke & Charles, 2016). Parents' attitude interrupted and poor teaching leads to dyscalculia in mathematics (Attwood, 2014). This can be a factor that the learners never feel or think that math could be the easiest one.

Similarly, the abstractness of our curriculum can be another factor in having math phobia. Not only the student but also we teachers are unable to connect most of the portion of it in our daily life and daily practice. Sometimes, theorem itself seems very complicated and fearful in its appearance. In my view, unless and until we teachers can connect our math to the daily environment of the learners, it would be very difficult to grab their attention towards the subject. The adjoining figure is one example of the theorem, where my students feel difficult most of the time. They leave such theorems without trying even a single time assuming that it could be very difficult to prove as its figure seems very complicated. From this point of view, I have

experienced that the figures also must be presented in such a way so that students do not avoid them by looking at its appearance.

Further, Sa'ad et al. (2014) argued that the lack of fund to purchase necessary materials, poorly coordinated teachers activity, lack of well-trained teachers, poor quality of textbooks, poorly motivated teachers, large classes, lack of library and practical materials, the negative role of public examinations on teaching and learning process, incessant transfer of teachers, interference of the school system by the civil services, and inequality in educational opportunities all hamper the smooth acquisition of mathematics knowledge. This can be a great cause of poor and demotivated performance in mathematics education which leads to mathematics phobia.

Theoretical Framework

This section consists of theoretical perspectives of my study. In this section, the researcher has connected different theoretical ideas related to the construction of knowledge of geometry theorems with the supportive literature. "The theories are the bases on which the ideas can be presented" (Shrestha, 2018, p. 31). In another sense, I can say that these theories are the means for constructing knowledge in the present study.

Firstly, this section includes social learning theory which enables students to build up the basic concepts of geometrical proof and supports the interactive environment in any type of learning. Secondly, Habermassian's theory of fundamental human interests that can construct knowledge through three different perspectives in proving theorems. Thirdly, the Van Hile model of geometrical thinking, which consists of five levels (from 0 to 4) that drive me to find the level of the students' thinking in geometrical theorem proof. These theories are applicable in the

acquisition of knowledge of any learner in proving theorems and also helps me to justify my study and findings. The theories are discussed below.

Social Learning Theory

Society is the first school of any individual. A person starts learning from society. In my view, whatever a person can think act or perform in any condition, there should be the influence of society. In mathematics learning, social interaction matters a lot. So, I feel that social interaction with the peers, teachers and others enhances learning. Lev Vygotsky believed that knowledge can be constructed through social interaction. “The origin of learning is not at the individual level, but at the social” (Jeon Kyungsoon, 2000, p. 41). From this, I came to know that our mathematics cannot be separable from this theory. In my experience, the learning geometry theorems is largely impacted by interaction. It is very difficult for any student to understand and prove the theorems without the help of either teachers, peers or any other people having more knowledge. The students of grade IX and X can learn the various ways of proving theorems after the deep interactions. According to Jeon Kyungsoon (2000), “learning takes place in the socio-cultural framework through ZPD and there exists the pseudo concept before it gets to a true concept” (p. 41). It means that any student can learn anything through ZPD and before constructing true knowledge that he/she constructs the pseudo concept. In our curriculum of school level (Grade IX, X), I think the concepts of theorems are quite higher than the ability of a child. I have found that most of the students have anxiety about theorems. In my experience, even the high scorers in mathematics also have problems in this section. So, I believe that this phobia and abstractness of this section can be solved through deep interaction and investigation. In my view, if the learners

are kept in an interactive mode of learning, they can easily construct better concepts of geometry theorems.

In this study "social learning theory" helps the researcher to select and design appropriate methodologies in the research field. The researcher has acquired the data through social interactions with the participants. In this scenario, this theory helps the researcher to reach up to the findings.

Habermasian Theory on Human Interest

Jurgen Habermas believes that any knowledge can be constructed through three different interests (Grundy, 1987). They are Technical, Practical and Emancipatory Interests. In this study, the researcher believes that the learning geometry theorem in the emancipation of human is less contributing, so, the researcher decided to take technical and practical human interests as his theoretical referents.

Technical Interest

Learning geometrical theorems at school level is a very big challenge for any learner. The construction of knowledge in this section is highly technical as students need to follow the strict rules and methods to prove any theorems. For Fraser and Bosanquet (2006) "a technical interest focuses on structuring and managing objects and the environment" (p. 279). The development of knowledge in learning Geometry theorems is guided by "empirical-analytic sciences" (Grundy, 1987, p. 12). The way of teaching and learning geometry theorems is positivist and there is less chance of emancipation. Grundy (1987) argued, "the technical interest is: a fundamental interest in controlling the environment through rule-following action based upon empirically grounded laws" (p. 12). In my experience, the jumpy nature of math teachers is

making mathematics more difficult and I can say that the acquisition of geometrical knowledge is technical in our context.

Technical interest guides the researcher to find the factors affecting the learning geometry theorems. The first phase study of this research study advocates for objective reality, so, this theory helped the researcher to analyze the quantitative data to get the findings on the research agenda.

Practical Interest

According to Habermas; the knowledge is generated through interaction or communication between two individuals or within a group is called practical interest. The construction of knowledge depends on the discussion, interaction under a certain consideration. I have found that the students can prove the geometry theorems through the interaction with their peers and can build up a better idea and concepts through it. In this sense, learning geometrical proof is guided by practical interest too. "The key concepts associated with the practical cognitive interest are understanding and interaction" (Grundy, 1987). To prove any geometrical theorems, it is necessary to understand it and the learner can interact with his/her peer or more knowing people in the necessary condition. Grundy (1987) argued that practical interest generates subjective knowledge rather than objective knowledge. In my opinion, the idea of proving geometry theorems is more subjective as it can be proved by various ways of logics.

As the second research question in this study has investigated the subjective experiences of the learners, teachers, curriculum experts and subject experts in learning geometry theorems. The practical interest has guided the researcher to make a prolonged engagement with the participants in this study. This theory helped the

researcher to construct knowledge on subjective reality and also guided to interpret it to reach up to the findings and conclusion of the study.

Van Hiele Theory

Pierre van Hiele and his wife Dina van Hiele-Geldof were Dutch researchers and teachers who developed this theory as their doctoral work out of the frustrations both they and their students experienced with the teaching and learning of school Geometry in the late 1950s. “The theory originated in their thesis at the University of Utrecht in 1957” (Vokuvkova, 2012, p. 72). Students still have difficulty in geometric thinking (Hardianti et al., 2017; Abidin, 2011) and it is indicated that the level of geometric concept mastery is still not maximized at the high school (Sunardi, 2016) and Higher Education. Similarly, Atebe and Schafer (2008) also noted in their study that students’ mathematical competencies have been closely linked to their levels of geometric thinking. Van Hiele (1986) also explains, “It always seemed as though I were speaking a different language” (p. 39) when teaching geometry to his students. In this scenario, “Van Hiele model was formed to improve geometrical comprehension and this model was developed in classroom settings” (Erdogan & Durmus, 2009, p. 155). The scenario is the same in our context too as I have experienced that the majority of the students in schools feel the terminologies and statements of geometry are as if from another planet. Van Hiele wanted to know why their students experienced difficulty in learning geometry and how they could resolve those challenges. Van Hiele’s theory is one of the learning theories which can improve students' thinking ability levels in learning geometry (Tan, Tarmizi, Yunus, & Ayub, 2015). The result of their investigation and the solution to their difficulty in geometry they developed five levels of understanding in geometry “which includes 5 levels of level 0 (visualization), level 1 (analysis), level 2 (informal deduction), level

3 (deduction), and level 4 rigor (accuracy)" (Fitriyani, Widodo & Hendroanto, 2018, p. 56).

Level 0: Visualization

At this level, a learner knows geometric shapes like triangle, circle, square, cube without knowing their properties and may compare to their existing knowledge to identify the shapes which they have experienced in their surroundings. "At this level, pupils use visual perception and non-verbal thinking" (Vojkuvkova, 2012, p. 72). For example, a student feels but cannot distinguish between a rhombus and a square.

Level 1: Analysis

At this level, students analyze the figures and their properties but do not understand the relation between them. They do not see the importance of the necessary and sufficient properties of any geometric figures.

Level 2: Informal deduction (Abstraction)

At this level of van Hiele theory, a student can develop meaningful definitions and can give informal arguments to deduce one statement from another. "They can draw logical maps and diagrams" (Vojkuvkova, 2012, p. 73). "For example, the square is also a rectangle" (Yudianto, Sunardi, Susanto, & Trapsilasiwi, 2018, p. 2).

Level 3: Formal deduction

At this level students can develop a proof for any geometrical statement, can distinguish between the statement and its converse can be made. A learner can understand the interrelationship and role of geometric terms, axioms, postulates, definitions, theorems and "can give deductive proof" (Vojkuvkova, 2012, p. 73).

Level 4: Rigor

At this stage, learners can know the mathematical system and proof related to Euclidean and non-Euclidean Geometry to describe and able to use correct axioms on a given geometric system (Vojkuvkova, 2012). A student at the rigour level can go through 0 level to 3 level which means he has reversible thinking ability (Viglietti, 2011; Yudianto et al., 2017).

"One of the theories that help greatly and effectively in teaching geometry is van Hiele which attracted scholars and educationists' attention the world over because it helps effectively in teaching geometry to the students through the school stages" (Al-ebous, 2016, p. 88). Van Hiele's levels of geometric thinking plays an important role in learning geometry and "guides a teacher's practices in class and explains the difficulties encountered by the students in Geometry" (Ural, 2016, p. 13). As this study incorporates the theorem learning in secondary schools which lies in the fourth level of Van Hiele model i.e. formal deduction, this guides the researcher to find the level of students' understanding of Geometry based on the collected data. The van Hiele's level of Geometry learning gives a reasonable explanation, how students learn Geometry at the school level. This theory originally developed using two-dimensional geometry has a very close relation to our school Geometry. Fitriyanin, Widodo and Hendroanto (2018) noted, "it is necessary to identify also the level of students' geometric thinking in mathematics education program to prepare better mathematics teachers in the future" (p. 57). Similarly, several other countries have applied this theory to improve Geometry instructions (Mostafa, Javad & Reza, 2017). It is a "theory that concerns the stages of thinking of students in the delegation of geometry and learning phase that can be used in the learning process" (Muchsin, Kamaruddin,

& Rosida, 2018, p. 1). In this scenario, the researcher found this theory closely connected with this research study and helped him to understand the students' level of thinking in learning Geometry theorems.

Empirical Reviews

In this section, the researcher has reviewed the articles, dissertations and other research studies related to Geometry and Geometry theorems. The reviewed studied helped the researcher to formulate the hypothesis and research questions. The researcher felt the need for this study based on the reviewed researches and designed the purpose of the study on Geometry theorems in his context. This review is a critical review in which the literature critically provides the foundation on which the research is built.

Thaguna (2015) conducted his study on "Exploring learning difficulty in school level Geometry". The methodology of this research study is auto-ethnographic inquiry where the researcher expressed himself as a transformative researcher. In this research study, the researcher puts his major focus on the value of Geometry and interest of students in Geometry learning where the researcher has compared his experiences in his teaching and learning Geometry theorems. This study concluded, "life-like Geometry is need of teaching Geometry in the classroom" (p. 117). Although this study is also related to learning difficulty in school Geometry, my research agenda is different from this in terms of methodology and area of study as I dealt with Geometry theorems whereas this study in on overall Geometry.

Likewise, Shrestha (2018) has conducted his study on "Embodiment of geometry in traditional Newari art". This research is a qualitative ethnographic inquiry on geometrical practices in a Newari culture. The objective of the study was to find the integration between basic level school geometry and traditional religious

Newari art and drawing. The researcher has found out that society is full of culture and if the cultural aspects can be integrated into the classroom then teaching and learning can be more meaningful. This research is about ethno-geometry in general for the basic level whereas my study is on geometry theorems for secondary level.

Worry (2011) has completed a study on "A comparison of high school Geometry student performance and project-based Instruction Techniques" in his doctoral study. His research methodology is quantitative quasi-experimental. The objective of the study was to know the significant difference between project-based instruction and lecture-based instruction in the students' performance and motivation in learning geometry for high schools. In this study, the researcher concluded that the project-based instruction benefits students both in their achievement and their level of motivation than lecture-based instructions. This study is based on geometry learning through two strategies whereas my research agenda is different from this.

Frasier (2010) has conducted his study on "secondary school mathematics Teacher's conception of proof" in his doctoral dissertation where he tried to explore the teachers' view in the mathematical proving. This was online survey research which investigated in-service high school mathematics teachers' conceptions and practices about mathematical proof. In this research study, the researcher found out that the teachers' conceptions of proof are composed of four principal components. Although this study is based on mathematical proof, my issue of research is unique.

Antink (2010) studied "Geometry success, Brain Theory and community Building" in his doctoral research thesis. The study was conducted through action research method which aimed to improve students' geometry achievements and retention in a suburban public high school over a one-year implementation cycle and found out the progressive improvements of the students on the standard test in

geometry. This study was conducted to check the strategies in geometry learning but my study tried to enhance the problem in learning geometry theorems, so I found my topic does not have any intersection here.

Belbase (2015) conducted his doctoral research on the topic “pre-service secondary Mathematics Teachers’ beliefs about teaching Geometric Transformations using Geometer’s Sketchpad”. This research focused to explore the beliefs held by pre-service secondary mathematics teachers about teaching geometric transformations with geometer's sketchpad. This study was guided by qualitative methodologies to reach up to the findings with the focus on both the integrated and diversified pedagogy of mathematics education with technology. In this scenario, I have found my topic is very unique as it tried to explore the problems in learning geometry theorems proof. It tried to address the experiences of both students and in-service secondary mathematics teachers in my study whereas this research studied only the belief of pre-service secondary mathematics teachers.

Thapa (2016), conducted his interpretive research design through the narrative method on the topic “Geometry Anxiety in Secondary Level in Grade Nine” aiming to explore the causes of geometry anxiety in secondary level students and to find the possible ways to minimize the anxiety. In this study, the researcher found out that the students had difficulties in geometry due to the use of traditional teaching and learning approach, lack of visualization, poor geometrical language and concept and also found out that the majority of the math teachers were not using concrete teaching materials while teaching geometry. The researcher also found out that collaborative learning, the use of local materials in the classroom and linking the content to the learners’ context can minimize geometry anxiety at the secondary level. After going

through this study, I explored my research agenda different from this study and is a new topic to be studied in my context.

The above studies are based on geometry teaching and learning but I found that my topic “Learning geometry theorems for grade IX and X” is very unique. I have not got any findings which can be exactly same as my issue. This encouraged me to research exploring learning problems on the geometry of grade IX and X students in my context.

Research Gap

The above research studies show that many studies have been conducted in different places around the world and in our country on the different aspects of teaching and learning geometry. I found that many of the researchers focused on the teaching and learning of geometry as a whole. But I could not find any research conducted especially on “Geometry Theorems”. It could be a very unique topic from the cultural perspective in the field of research which has explored the problems in learning geometrical proofs for grade IX and X students in our Nepali context. Hence, I researched the “problem of teaching and learning of geometry theorems” in grade IX and X to explore the obstacles faced by teachers and students in the acquisition of knowledge of Geometry Theorems.

Conceptual Framework

This section presents the conceptual framework of my research. “A conceptual framework explains either graphically or in narrative form the main things or the key factors/variables are their relationship to be studied” (Khanal, 2018, p. 82). After reviewing the above literature on learning Geometry in school mathematics of Nepali curriculum, I found out that they are not such research studies which have found the

problems and the reasons behind the problems in learning geometry theorems. The researcher has presented this study in the framework below.

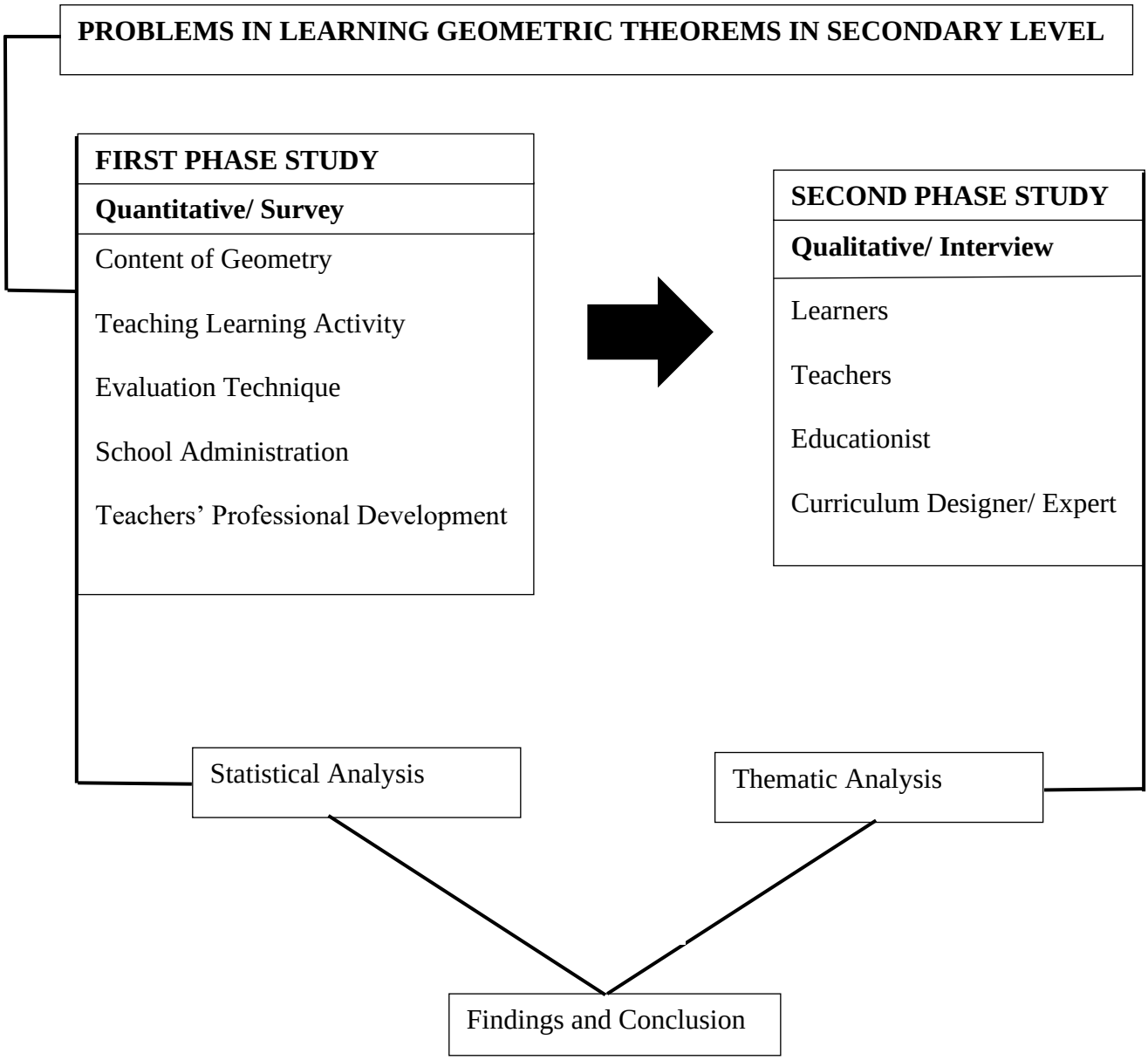

Figure 3: Conceptual framework of the study

The above framework shows the quantitative and qualitative parts as the two sides of the same coin and contributes the equal importance in this study. After analysing the responses collected from the first phase study, the researcher was keen to know the reasons behind the level of problems found from the first phase study in a subjective manner. The researcher believes that if we know the reasons which are causing the problems in any area, then it will be helpful to design the strategies which

can work as remedial support to minimize the problem. The interest to search the reasons behind problems found out from the first phase study. The framework shows that content of geometry, teaching-learning activities, school administration, evaluation techniques and teachers' professional development are the components which explore the problems in learning geometry theorems through survey method whereas learners, teachers, educationist and curriculum expert/ developers were interviewed for the qualitative study to address the need of second research question i.e. to investigate the reason behind the problems found out from the survey in learning geometry theorems.

CHAPTER III

SETTING THE ROADMAP OF RESEARCH: METHODOLOGY

In this section, the researcher identifies his/her research method. The section begins with a discussion of the research design and the justification for choosing the design. The setting and the sample of this study are discussed including descriptions of the population and how the research sample was chosen. This chapter incorporates the tools through which this research was designed.

Methodology

The purpose of this study was to explore the difficulties in teaching and learning of geometry theorems in grade IX and X in the Nepalese context and tried to find why they were feeling so, to address the outcomes of the first research question. The first research question has been addressed through the quantitative approach and the second one by the qualitative approach. In this scenario, the sequential explanatory mixed-method research design was applicable to carry out this study meaningfully. "Mixed method research is a procedure for collecting, analyzing and mixing both quantitative and qualitative data in a single study or a series of studies to understand the research problem" (Creswell & Plano Clark 2011, as cited in Creswell, 2015, p-535). In this sense, this approach of study aims to conclude both quantitative and qualitative approaches one after another. For this, the researcher needs to understand both the ways of research tools. Among the different forms of mixed-method study, the sequential explanatory mixed-method study was appropriate to address the issue of this study. In the research design of this study, the researcher firstly collected the numerical data through the survey method covering a large

number of students and teachers to address the first question. Varun Grover (2000) argued that the meaning of the research survey is a collection of information from a large group of people with some structured format with the focus on advancing scientific knowledge or developing theory. The survey was conducted in the government schools of Tokha Municipality. Secondly, the next question was addressed with the subjective experiences of the selected participants connected with the school mathematics and the secondary level of the Nepalese Education system.

Ontology

Ontology is a philosophical study of being. Moreover, it studies concepts that directly relate to being, in particular becoming, existence, reality, as well as the basic categories of being and their relations. In general, we have two kinds of reality. The first one is a single reality which is also called objective reality and the second one is multiple reality which is subjective. In this research study, the first or the quantitative section rises to objective reality whereas the second section or the qualitative part is addressed with the subjective experiences of the learners, teachers, subject experts, and selected policymakers.

Epistemology

Epistemology is a philosophical concern which deals with the theory of knowledge. It is a method of obtaining true knowledge by a human being. In this research study, as I focused on geometry theorems where the knowledge acquired by most of the students was an algorithmic solving process, the method of teaching and learning was still conventional in this context. In this scenario, the acquisition of knowledge of students was objective kind whereas the problem-solving approach of each teacher could be different from one another which was of subjective kind of knowledge. It shows that both kinds of knowledge were used in this study.

Axiology

Axiology is a philosophical worldview which deals with the theory of value. It is a collective term of ethics and aesthetics. Ethics investigates the concepts of right and good in individual and social conduct. Aesthetics studies the concept of beauty and harmony. The sense of the value can differ according to each individual and context. So, in this research, I gave value to every respondent/participant who was part of the study. It was quite a complicated scenario for the researcher in this study because of the devastating moment of COVID-19. The researcher was not able to reach to all participants physically and both types of data were collected through the online mode.

Nature and Source of Data/ Information

In this research study, the researcher collected the data in both numerical and subjective forms, so the study is mixed. The first phase of the study incorporated numerical and statistical data whereas the second phase of the study incorporated the feelings, emotions, beliefs, practices, and assumptions through interviews of selected students, teachers and subject experts in geometry theorems. The ultimate source of these kinds of data were the responses of grade IX and X students of Tokha municipality and the teachers who have long experience of teaching school mathematics and experts working in the related field.

Introducing the Research Site

This research study was conducted at a government high school located in Tokha Municipality of Kathmandu district. There are 7 government high schools and 895 students in grade IX and X, where 485 students in grade IX and 411 students in

grade X. The students of these levels and the teachers of the same levels were taken as respondents to get the required data and information.

Population and Sample of the Study

This study used two methodologies; survey and interview. This section provides the sample for my quantitative data. The population of my study was 895 students of Tokha Municipality from 7 different schools. The sample of my study for the quantitative part was selected by the simple random sampling method. As mention in the sampling table (See appendix D) provided by Cohen, Manion & Morision (2007), the sample size of the study, the population was 900 at the confidence level of 95% was 269. The population of my study was also likely to be equal in this criteria, so, I took the sample size of 270 students chosen from the selected schools where 120 students were from grade X and 150 were from grade IX. There were 141 male students and 129 female students who participated in the students' survey. In the case of the teacher's sample, the researcher tool all the secondary mathematics teachers of the research site in the survey.

Selection of Sample Schools

The number of students from selected schools was heterogeneous. In this study, the researcher addressed all the schools as far as possible. Among the 7 selected schools, one school had only 15 students in their secondary level, so, I took the remaining 6 schools to get the average number of students for my sample size. The nature of students in case of culture, economic status, and social background was similar in other selected schools, so my opinion in the case is that 15 students can be addressed from the other selected students.

No. of sample students from each school $= \frac{270}{6} = 45$

Therefore 45 students were selected from each school for the survey method.

Sample for the Interview

For the qualitative study, the researcher selected two students from different schools, two teachers from different schools, and an educationist and a curriculum expert through purposive sampling method to serve the need of second phase (qualitative) study to know the in-depth problem faced by the teachers and students while learning Geometry theorems. In this sampling technique, the researcher got what to be known and decided to set out in the search of people who were capable along with their desire to provide with information by knowledge or experience (Bernard 2017, Lewis & Sheppard 2006). For this data collection, face to face interview was conducted in different sessions with students, teachers, and other participants individually. The researcher designed a semi-structured questionnaire before the interview based on the result observed from the quantitative data provided by the students and the researcher's experiences. The researcher tried to integrate the outcomes of the quantitative observations from the students with qualitative data of the teacher's experiences and perceptions.

Data Collection/Generation Tools

Firstly, to conduct the survey and to address my first research question, I prepared the questionnaire to address the factors affecting learning Geometry theorems based on classroom pedagogy. The questionnaires were designed separately for the teachers and students. At the beginning of designing the questionnaires, the researcher randomly prepared the statements as much as possible, then in the continuous sitting with the supervisor and other experts in the related field from Kathmandu University, the statements got refined and got the shape of the current pattern. The continuous observations of my supervisor and the experts helped me to

refine the structure, language, content, and other aspects of the statements in the questionnaires for the survey. The questionnaires for the students were categorized into four content subtopics, teaching-learning activities, school administration, and evaluation techniques whereas the questionnaires for the teachers were divided into content, teaching-learning activities, school administration, and teachers' professional development. The quantitative data were collected through the questionnaires. For this, I selected the six government schools' students of Tokha Municipality which I mentioned earlier too. The responses of the teachers and students were collected through google form in online mode.

Secondly, I conducted the interviews with the students, teachers of the same level, and with the policymakers and subject experts of Nepali context in the field of school mathematics to address my semi-structured questions based on my experiences and the factors resulted from the conclusion of the first research question. While doing so, I selected 2 students from different schools, 2 teachers from different schools, an educationist, and a policymaker/ curriculum expert with a long teaching experience and working in the related field for the same level. After interacting with these participants in the interview, I found out that the collected data were sufficient for this study, so I stopped my interview and analysed them based on the collected experiences. All the interviews were collected through Google Meet in the recording form in online mode

Piloting Analysis

In this research study, the researcher conducted a pilot study to ensure the reliability and validity of the tool. Moreover, the purpose of this test was also to refine the statements of the tool. It is necessary to pilot a prepared instrument or a tool in a small group that had "the same profile with the subjects of the study" (Brown and

Dowling, 1998) and was not part of the sample. While doing so, the researcher selected a similar group of students and teachers as in the sample from the nearby municipalities of Kathmandu district. The reason lied in the way that pilot-testing assisted with realizing where undesired slip-ups were made, and allowed a chance to change the inquiries of the investigation (Khanal, 2018). As suggested by Dooley (2004) on the off chance that the pilot study doesn't create reasonable outcomes, at that point then the researcher revises and modifies the items until s/he gets a legitimate instrument that can produce what it is supposed to do.

In this process, the researcher distributed the questionnaires through the online mode because of the pandemic situation of COVID-19. Firstly, the researcher made a network with few teachers in government schools from nearby municipalities and distributed the questionnaires to the students through an online plate-form. While collecting the data from the teachers, the researcher personally mailed the teachers and collected it by the follow-up process. 64 students and 20 teachers were taken for the piloting analysis besides the sample. The researcher collected all the responses for the pilot test in the Google form. The return rate of the questionnaire was 98% in the case of teachers and 96% of students.

Refinement of Statements

After collecting the data from the pilot test the researcher analyzed the data by using SPSS25 [Statistical Package for the Social Sciences 25]. The data were analyzed by using five statistical thumb rules such as the mean of the item, standard deviation (SD), item-total correlation, skewness, and kurtosis.

Refinement of Students' Questionnaire

While using the five-thumb rule in refining the instrument, the researcher firstly used the mean criteria where the mean between 2 to 4 was to be accepted and

others were to be rejected for the further process (Jang and Roussos, 2007). Taking mean into account, one item was rejected as it's mean in the above criteria. The remaining statements were used for further analysis of refining.

	Statistics								
		N		Mean	Std. Devia	Skewness	Std. Error	Kurtosis	Std. Error of Kurtosis
		Valid	Missing						
30	We have facility of Math Lab at our school	64	0	2.2	1.026	0.758	0.299	-0.13	0.59
4	I feel geometry theorems are more compl	64	0	2.53	1.083	-0.044	0.299	-1.26	0.59
39	I feel difficulty in proving geometry theore	64	0	2.61	1.002	0.178	0.299	-0.745	0.59
11	I feel difficult to solve the geometry theore	64	0	2.69	1.037	0.139	0.299	-0.649	0.59
13	I feel theoretical learning seems difficult th	64	0	2.75	1.008	0.24	0.299	-0.327	0.59
8	I feel geometry theorems are less practica	64	0	2.8	1.057	0.256	0.299	-0.483	0.59
10	I see the less practical application of geom	64	0	2.8	1.056	0.125	0.299	-0.661	0.59
44	Our teacher focuses more on the scores (i	64	0	2.81	1.111	0.456	0.299	-0.579	0.59
6	I feel complicated to translate the words ir	64	0	2.86	1.021	0.106	0.299	-0.597	0.59
12	I see the theorems are less connected wit	64	0	2.94	1.022	0.036	0.299	-0.759	0.59
35	Manipulative geometrical materials (e.g. C	64	0	2.98	1.016	0.22	0.299	-0.494	0.59
45	The three hours exam in Mathematics is n	64	0	3	1.26	0	0.299	-1.125	0.59
25	The frequent change of teachers in short p	64	0	3.02	1.134	0.036	0.299	-0.901	0.59
24	Our teacher focuses more on theoretical p	64	0	3.03	1.112	-0.349	0.299	-0.579	0.59
17	Our teacher uses ICT (Information and Co	64	0	3.2	1.287	0.068	0.299	-1.304	0.59
32	Our school focus is only on the scores (i.e.	64	0	3.22	1.215	-0.216	0.299	-1.079	0.59
36	Our school do not reward the high achievi	64	0	3.23	1.123	-0.274	0.299	-0.572	0.59
23	I find the teaching-learning materials used	64	0	3.25	1.054	-0.021	0.299	-1.098	0.59
9	I feel easy while proving geometry theorer	64	0	3.36	0.804	-0.375	0.299	-0.749	0.59
29	We have good access of internet at our scl	64	0	3.44	1.194	-0.223	0.299	-0.971	0.59
34	We feel difficulty to actively participate in	64	0	3.5	1.098	-0.371	0.299	-0.725	0.59
14	The content of geometry theorem is enou	64	0	3.56	0.794	-0.604	0.299	0.873	0.59
37	Our teacher checks our homework daily.	64	0	3.56	1.139	-0.325	0.299	-0.842	0.59
33	The division of section of our class is accor	64	0	3.58	1.11	-0.886	0.299	0.295	0.59
2	I can understand the verbal problems in g	64	0	3.61	1.002	-0.115	0.299	-1.024	0.59
21	I am afraid of asking questions with my te	64	0	3.67	1.196	-0.537	0.299	-0.891	0.59
41	Our teacher provides more opportunity fo	64	0	3.69	1.022	-0.437	0.299	-0.498	0.59
26	Our teacher provides more opportunity fo	64	0	3.72	1.046	-0.607	0.299	-0.098	0.59
1	I can understand the terminologies used ir	64	0	3.73	1.012	-0.576	0.299	0.096	0.59
22	Our teacher focuses in group works while	64	0	3.73	1.027	-0.254	0.299	-1.069	0.59
40	Our teacher takes different types of test su	64	0	3.77	1.02	-0.435	0.299	-0.872	0.59
31	Because of maximum extra-curricular activ	64	0	3.81	1.006	-0.672	0.299	-0.127	0.59
27	Our teacher focuses on our curiosity in lea	64	0	3.83	1.017	-0.391	0.299	-0.956	0.59
3	I can see the theorems are interconnected	64	0	3.84	1.027	-0.584	0.299	-0.729	0.59
15	Our classes of geometry begins in an inter	64	0	3.86	1.006	-0.579	0.299	-0.262	0.59
43	Our teacher motivates us in proving geom	64	0	3.86	1.006	-0.482	0.299	-0.818	0.59
20	Our teacher less response to all the studer	64	0	3.88	1.031	-0.728	0.299	-0.164	0.59
38	Our teacher provides regular feedback of	64	0	3.88	1.031	-0.459	0.299	-0.951	0.59
5	I feel comfortable in proving geometry th	64	0	3.89	1.01	-0.825	0.299	0.105	0.59
7	I feel easy to prove geometry theorems wl	64	0	3.91	1.019	-0.457	0.299	-0.956	0.59
19	Our teacher provides extra similar probler	64	0	3.91	1.035	-0.518	0.299	-0.904	0.59
28	I feel easy to learn geometry theorems wit	64	0	3.91	1.035	-0.937	0.299	1.143	0.59
42	Our teacher provides us multiple ways of	64	0	3.91	1.019	-0.55	0.299	-0.798	0.59
18	Our teacher provide enough opportunity f	64	0	3.97	1.038	-0.638	0.299	-0.774	0.59
16	Our teacher fully supports and guides us v	64	0	4.52	0.666	-1.055	0.299	-0.038	0.59

Figure 4: Sample of mean Criteria in Piloting Analysis on Students' Response

Similarly, Jackson (1970) suggested that SD greater than 1 was to be accepted and others to be rejected, in this regard taking SD into account two items were rejected as the value of SD was less than 1. The items which did not fulfil the SD

criteria were not used in the further process. In this process of refining the statements, the researcher thirdly applied skewness and kurtosis in the instrument data. According to Finney and Distefano (as cited in Junnarkar, Singh, & Kaur, 2016, p. 21), the items having skewness and kurtosis greater than absolute values 3 and 8 respectively should be removed from the mechanism. While taking this criterion for skewness and kurtosis, no items were rejected as all the statements fulfilled this criterion.

	Statistics								
		N		Mean	Std. Devia	Skewness	Std. Error	Kurtosis	Std. Error of Kurtosis
		Valid	Missing						
17	Our teacher uses ICT (Information and Co	64	0	3.2	1.287	0.068	0.299	-1.304	0.59
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32	Our school focus is only on the scores (i.e	64	0	3.22	1.215	-0.216	0.299	-1.079	0.59
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37	Our teacher checks our homework daily.	64	0	3.56	1.139	-0.325	0.299	-0.842	0.59
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4	I feel geometry theorems are more compl	64	0	2.53	1.083	-0.044	0.299	-1.26	0.59
8	I feel geometry theorems are less practica	64	0	2.8	1.057	0.256	0.299	-0.483	0.59
10	I see the less practical application of geom	64	0	2.8	1.056	0.125	0.299	-0.661	0.59
23	I find the teaching-learning materials usec	64	0	3.25	1.054	-0.021	0.299	-1.098	0.59
26	Our teacher provides more opportunity fo	64	0	3.72	1.046	-0.607	0.299	-0.098	0.59
18	Our teacher provide enough opportunity	64	0	3.97	1.038	-0.638	0.299	-0.774	0.59
11	I feel difficult to solve the geometry theor	64	0	2.69	1.037	0.139	0.299	-0.649	0.59
19	Our teacher provides extra similar proble	64	0	3.91	1.035	-0.518	0.299	-0.904	0.59
28	I feel easy to learn geometry theorems wi	64	0	3.91	1.035	-0.937	0.299	1.143	0.59
20	Our teacher less response to all the stude	64	0	3.88	1.031	-0.728	0.299	-0.164	0.59
38	Our teacher provides regular feedback of	64	0	3.88	1.031	-0.459	0.299	-0.951	0.59
22	Our teacher focuses in group works while	64	0	3.73	1.027	-0.254	0.299	-1.069	0.59
3	I can see the theorems are interconnected	64	0	3.84	1.027	-0.584	0.299	-0.729	0.59
30	We have facility of Math Lab at our schoo	64	0	2.2	1.026	0.758	0.299	-0.13	0.59
12	I see the theorems are less connected wit	64	0	2.94	1.022	0.036	0.299	-0.759	0.59
41	Our teacher provides more opportunity fo	64	0	3.69	1.022	-0.437	0.299	-0.498	0.59
6	I feel complicated to translate the words i	64	0	2.86	1.021	0.106	0.299	-0.597	0.59
40	Our teacher takes different types of test s	64	0	3.77	1.02	-0.435	0.299	-0.872	0.59
7	I feel easy to prove geometry theorems w	64	0	3.91	1.019	-0.457	0.299	-0.956	0.59
42	Our teacher provides us multiple ways of	64	0	3.91	1.019	-0.55	0.299	-0.798	0.59
27	Our teacher focuses on our curiosity in lea	64	0	3.83	1.017	-0.391	0.299	-0.956	0.59
35	Manipulative geometrical materials (e.g. C	64	0	2.98	1.016	0.22	0.299	-0.494	0.59
1	I can understand the terminologies used i	64	0	3.73	1.012	-0.576	0.299	0.096	0.59
5	I feel comfortable in proving geometry th	64	0	3.89	1.01	-0.825	0.299	0.105	0.59
13	I feel theoretical learning seems difficult t	64	0	2.75	1.008	0.24	0.299	-0.327	0.59
31	Because of maximum extra-curricular acti	64	0	3.81	1.006	-0.672	0.299	-0.127	0.59
15	Our classes of geometry begins in an inter	64	0	3.86	1.006	-0.579	0.299	-0.262	0.59
43	Our teacher motivates us in proving geom	64	0	3.86	1.006	-0.482	0.299	-0.818	0.59
39	I feel difficulty in proving geometry theore	64	0	2.61	1.002	0.178	0.299	-0.745	0.59
2	I can understand the verbal problems in g	64	0	3.61	1.002	-0.115	0.299	-1.024	0.59
9	I feel easy while proving geometry theore	64	0	3.36	0.804	-0.375	0.299	-0.749	0.59
14	The content of geometry theorem is enou	64	0	3.56	0.794	-0.604	0.299	0.873	0.59

Figure 5: Sample of SD Criteria in Piloting Analysis on Students' Response

Lastly, the researcher applied the item-total correlation to refine the final level of the instrument. According to Field (2005; 2013), item-total correlation "less than 0.2 or 0.3" of any item is to be rejected and 3 statements were rejected taking this criterion into account as their value was less than 0.2.

Finally, the reliability of the instrument in this study was measured by using Cronbach alpha in SPSS25. "This was seen appropriate because it required only a single test administration and provided a unique quantitative estimate of reliability for the given administration" (Bhattarai, 2015, p.69). Thirty-nine (39) items were left in the students' questionnaires which satisfies all five thumb rules and having the final reliability of $\alpha = 0.842$. The internal consistency was resolved by using Cronbach alpha which shows how well the items/ statements were correlated with one another. Nunnally and Bernstein (1994) suggested that one should reject those instruments whose value of Cronbach alpha is less than 0.60. Similarly, Santos (1999) argued that "for an instrument to be used, its internal reliability coefficient- Cronbach's alpha (α) must be at least 0.7" and thus the reliability for my instrument in this study was acceptable.

Table 1

Reliability of Students' Survey Tool

Reliability Statistics	
Cronbach's Alpha	N of Items
.842	39

Refinement of Teachers' Questionnaire

The researcher applied the same process and criteria in refining the questionnaires for the teachers. While doing so, 2 items were rejected which did not

satisfy the criteria of the mean. Just the same as in student's questionnaires, the rejected items were not kept in the further analysis.

	Statistics									
		N		Mean	Std. Devia	Skewness	Std. Error	Kurtosis	Std. Error of Kurtosis	
		Valid	Missing							
21	I am able to guide mu students in a single	20	0	1.8	1.05	-0.157	0.512	-1.144	0.992	
39	I am teaching geometry theorems in the s	20	0	2.15	1.342	0.985	0.512	2.448	0.992	
8	Students feel geometry theorems are less	20	0	2.15	1.137	1.11	0.512	0.829	0.992	
16	Geometry theorems in secondary mathem	20	0	2.3	0.979	0.801	0.512	0.253	0.992	
10	Students feel difficult to solve geometry th	20	0	2.35	1.387	0.74	0.512	-0.717	0.992	
14	The example in the text book are not enou	20	0	2.35	1.137	0.89	0.512	0.154	0.992	
12	Theoritical leaarning seems difficult than s	20	0	2.4	0.94	1.587	0.512	2.306	0.992	
30	Most of the students prefer to leave some	20	0	2.45	1.188	0.921	0.512	-0.246	0.992	
36	Students feel difficult in enough participat	20	0	2.6	1.095	0.523	0.512	-1.02	0.992	
9	Students feel easy while proving geometry	20	0	2.6	1.046	0.931	0.512	1.325	0.992	
37	Manipulative geometrical materials are les	20	0	2.65	1.226	0.376	0.512	-1.163	0.992	
17	Geometry theorems in mathematics less n	20	0	2.65	1.182	0.557	0.512	-0.165	0.992	
40	I am not getting effective training to teach	20	0	2.7	1.105	0.677	0.512	-1.548	0.992	
43	The training I have gained are not sufficien	20	0	2.75	1.164	-0.125	0.512	-1.577	0.992	
18	I am using ICT while teaching geometry cla	20	0	2.8	1.196	0.426	0.512	-0.74	0.992	
32	We have facility of math lab at school whi	20	0	2.8	1.005	-0.249	0.512	-0.999	0.992	
23	I think the content of Geometry is more th	20	0	2.95	1.234	-0.269	0.512	-1.211	0.992	
38	Our school do not reward the high achievi	20	0	3	1.214	0.196	0.512	-0.612	0.992	
41	I am less familair with the ICT tools which	20	0	3	1.076	0	0.512	-1.061	0.992	
26	I focus more for the high achieveing stude	20	0	3.05	1.468	-0.095	0.512	-1.402	0.992	
34	Our school focuses is only to the acores in	20	0	3.05	1.276	-0.44	0.512	-0.663	0.992	
2	My students can understand the verbal pr	20	0	3.1	1.19	0.17	0.512	-1.245	0.992	
3	Students feel difficult to find the connectic	20	0	3.25	1.446	-0.486	0.512	-1.111	0.992	
5	Students feel comfortable in proving geom	20	0	3.25	1.39	-1.105	0.512	2.612	0.992	
33	More extra activities in school are affectin	20	0	3.25	1.251	-0.526	0.512	-1.023	0.992	
31	We have good excess of internet at schoo	20	0	3.25	1.209	-0.335	0.512	-0.537	0.992	
11	I see the theorems are less connected with	20	0	3.25	1.07	0.018	0.512	-1.423	0.992	
25	I am able to provide feedback for all the st	20	0	3.3	1.38	-1.055	0.512	-0.208	0.992	
15	The poor foundation of students in prima	20	0	3.35	1.387	-0.575	0.512	-0.951	0.992	
35	The division of section of our classroom is	20	0	3.4	0.95	0.149	0.512	-1.22	0.992	
24	I am able to check all the copies of my stu	20	0	3.45	1.146	-0.331	0.512	-0.474	0.992	
1	My students can understand the terminol	20	0	3.5	1.132	-1.244	0.512	1.446	0.992	
7	Students feel easy to prove geometry thec	20	0	3.6	1.971	-1.198	0.512	1.418	0.992	
28	I feel easy to teach geometry theorems	20	0	3.6	1.188	-0.578	0.512	-0.443	0.992	
44	I am not update with the new theorems in	20	0	3.6	1.188	-1.206	0.512	0.689	0.992	
22	I can easily complete teaching Mathematic	20	0	3.65	1.309	-0.834	0.512	-0.24	0.992	
19	Students have psychological fear of the to	20	0	3.7	1.38	-0.865	0.512	-0.522	0.992	
27	I encourage students to participate in a gr	20	0	3.7	1.342	-1.276	0.512	0.522	0.992	
42	I have less competency in teaching geome	20	0	3.8	1.894	-1.04	0.512	0.766	0.992	
20	Because of less practice from student side	20	0	3.8	1.322	-1.416	0.512	1.128	0.992	
29	I think the use of appropriate ICTs tools cr	20	0	3.85	1.04	-0.607	0.512	-0.624	0.992	
6	Students feel complicated to translate the	20	0	3.9	1.54	-0.083	0.512	0.766	0.992	
4	Students feel geometry theorems are mor	20	0	3.9	1.124	-1.236	0.512	1.35	0.992	
13	The content of geometry is enough to give	20	0	4.32	1.372	-0.087	0.512	-1.001	0.992	

Figure 6: Sample of mean Criteria in Piloting Analysis on Teachers' Response

Secondly, 3 items did not satisfy the criteria of SD which were removed from the list. Same as in students' questionnaires, no item was rejected in the skewness and kurtosis analysis and all fell under the criteria.

	Statistics								
		N		Mean	Std. Devia	Skewness	Std. Error	Kurtosis	Std. Error of Kurtosis
		Valid	Missing						
7	Students feel easy to prove geometry theorems	20	0	3.6	1.971	-1.198	0.512	1.418	0.992
42	I have less competency in teaching geometry theorer	20	0	3.8	1.894	-1.04	0.512	0.766	0.992
6	Students feel complicated to translate the words	20	0	3.9	1.54	-0.083	0.512	0.766	0.992
26	I focus more for the high achieveing students	20	0	3.05	1.468	-0.095	0.512	-1.402	0.992
3	Students feel difficult to find the connection	20	0	3.25	1.446	-0.486	0.512	-1.111	0.992
5	Students feel comfortable in proving geometry	20	0	3.25	1.39	-1.105	0.512	2.612	0.992
10	Students feel difficult to solve geometry theorems	20	0	2.35	1.387	0.74	0.512	-0.717	0.992
15	The poor foundation of students in primary	20	0	3.35	1.387	-0.575	0.512	-0.951	0.992
25	I am able to provide feedback for all the students	20	0	3.3	1.38	-1.055	0.512	-0.208	0.992
19	Students have psychological fear of the topic	20	0	3.7	1.38	-0.865	0.512	-0.522	0.992
39	I am teaching geometry theorems in the same way	20	0	2.15	1.342	0.985	0.512	2.448	0.992
27	I encourage students to participate in a group	20	0	3.7	1.342	-1.276	0.512	0.522	0.992
20	Because of less practice from student side	20	0	3.8	1.322	-1.416	0.512	1.128	0.992
22	I can easily complete teaching Mathematics	20	0	3.65	1.309	-0.834	0.512	-0.24	0.992
34	Our school focuses is only to the acores in exam	20	0	3.05	1.276	-0.44	0.512	-0.663	0.992
33	More extra activities in school are affecting in	20	0	3.25	1.251	-0.526	0.512	-1.023	0.992
23	I think the content of Geometry is more than the	20	0	2.95	1.234	-0.269	0.512	-1.211	0.992
37	Manipulative geometrical materials are less available	20	0	2.65	1.226	0.376	0.512	-1.163	0.992
38	Our school do not reward the high achieving student	20	0	3	1.214	0.196	0.512	-0.612	0.992
31	We have good excess of internet at school to look	20	0	3.25	1.209	-0.335	0.512	-0.537	0.992
18	I am using ICT while teaching geometry classes	20	0	2.8	1.196	0.426	0.512	-0.74	0.992
2	My students can understand the verbal problem	20	0	3.1	1.19	0.17	0.512	-1.245	0.992
30	Most of the students prefer to leave some part	20	0	2.45	1.188	0.921	0.512	-0.246	0.992
28	I feel easy to teach geometry theorems	20	0	3.6	1.188	-0.578	0.512	-0.443	0.992
44	I am not update with the new theorems in geometry	20	0	3.6	1.188	-1.206	0.512	0.689	0.992
17	Geometry theorems in mathematics less match	20	0	2.65	1.182	0.557	0.512	-0.165	0.992
43	The training I have gained are not sufficient in	20	0	2.75	1.164	-0.125	0.512	-1.577	0.992
24	I am able to check all the copies of my students	20	0	3.45	1.146	-0.331	0.512	-0.474	0.992
8	Students feel geometry theorems are less	20	0	2.15	1.137	1.11	0.512	0.829	0.992
14	The example in the text book are not enough	20	0	2.35	1.137	0.89	0.512	0.154	0.992
1	My students can understand the terminologies	20	0	3.5	1.132	-1.244	0.512	1.446	0.992
4	Students feel geometry theorems are more	20	0	3.9	1.124	-1.236	0.512	1.35	0.992
40	I am not getting effective training to teach geometry	20	0	2.7	1.105	0.677	0.512	-1.548	0.992
36	Students feel difficult in enough participating becaus	20	0	2.6	1.095	0.523	0.512	-1.02	0.992
41	I am less familair with the ICT tools which can be	20	0	3	1.076	0	0.512	-1.061	0.992
11	I see the theorems are less connected with the	20	0	3.25	1.07	0.018	0.512	-1.423	0.992
9	Students feel easy while proving geometry theorems	20	0	2.6	1.046	0.931	0.512	1.325	0.992
29	I think the use of appropriate ICTs tools create	20	0	3.85	1.04	-0.607	0.512	-0.624	0.992
32	We have facility of math lab at school which	20	0	2.8	1.005	-0.249	0.512	-0.999	0.992
16	Geometry theorems in secondary mathematics	20	0	2.3	0.979	0.801	0.512	0.253	0.992
35	The division of section of our classroom is according	20	0	3.4	0.95	0.149	0.512	-1.22	0.992
12	Theoritical leaarning seems difficult than solving	20	0	2.4	0.94	1.587	0.512	2.306	0.992

Figure 7: Sample of SD Criteria in Piloting Analysis on Teachers' Response

Lastly, 3 items were rejected while applying item-total correlation which was also removed from the tool.

	Item-Total Statistics								
		Scale Mea	Scale Varia	Corrected Item-Total Correlation	Squared M	Cronbach's Alpha if Item Deleted			
27	I encourage students to participate in a gr	119.4	421.621	0.719	.	0.908			
3	Students feel difficult to find the connecti	119.85	418.766	0.713	.	0.908			
22	I can easily complete teaching Mathemati	119.45	423.103	0.71	.	0.909			
34	Our school focuses is only to the acores ir	120.05	425.418	0.684	.	0.909			
29	I think the use of appropriate ICTs tools c	119.25	432.829	0.673	.	0.91			
24	I am able to check all the copies of my stu	119.65	429.924	0.669	.	0.91			
18	I am using ICT while teaching geometry cl	120.3	429.379	0.65	.	0.91			
10	Students feel difficult to solve geometry th	120.75	425.776	0.617	.	0.91			
23	I think the content of Geometry is more th	120.15	430.029	0.615	.	0.91			
1	My students can understand the terminol	119.6	438.989	0.584	.	0.911			
19	Students have psychological fear of the to	119.4	428.147	0.578	.	0.91			
44	I am not update with the new theorems ir	119.5	433.632	0.566	.	0.911			
30	Most of the students prefer to leave some	120.65	455.397	0.559	.	0.915			
6	Students feel complicated to translate the	119.2	450.063	0.541	.	0.913			
8	Students feel geometry theorems are less	120.95	436.576	0.53	.	0.911			
43	The training I have gained are not sufficie	120.35	436.029	0.528	.	0.911			
40	I am not getting effective training to teach	120.4	441.832	0.524	.	0.912			
26	I focus more for the high achieveing stude	120.05	429.103	0.523	.	0.911			
41	I am less familair with the ICT tools which	120.1	438.832	0.511	.	0.912			
7	Students feel easy to prove geometry the	119.5	442.263	0.473	.	0.912			
28	I feel easy to teach geometry theorems	119.5	438.158	0.472	.	0.912			
15	The poor foundation of students in prima	119.75	434.829	0.454	.	0.912			
25	I am able to provide feedback for all the s	119.8	445.537	0.4	.	0.913			
17	Geometry theorems in mathematics less r	120.45	441.945	0.396	.	0.913			
20	Because of less practice from student side	119.3	439.905	0.386	.	0.913			
5	Students feel comfortable in proving geor	118.95	458.05	0.385	.	0.915			
42	I have less competency in teaching geome	119.3	459.063	0.383	.	0.916			
39	I am teaching geometry theorems in the s	120.95	458.576	0.34	.	0.915			
9	Students feel easy while proving geometr	120.5	460.263	0.335	.	0.917			
36	Students feel difficult in enough participat	120.5	457.211	0.323	.	0.916			
38	Our school do not reward the high achiev	120.1	450.411	0.317	.	0.915			
32	We have facility of math lab at school whi	120.3	453.168	0.307	.	0.915			
37	Manipulative geometrical materials are le	120.45	445.734	0.305	.	0.914			
11	I see the theorems are less connected wit	119.85	448.134	0.304	.	0.914			
31	We have good excess of internet at schoo	119.85	447.397	0.277	.	0.914			
4	Students feel geometry theorems are mo	119.1	450.2	0.243	.	0.915			
2	My students can understand the verbal p	120	444.211	0.139	.	0.912			
33	More extra activities in school are affectin	119.85	447.292	0.128	.	0.915			
14	The example in the text book are not eno	120.75	435.25	0.102	.	0.911			

Figure 8: Sample of Item-total Correlation Criteria in Piloting Analysis on Teachers' Response

Finally, 36 items were left in the teachers' questionnaires which satisfied all five thumb rules having the final reliability of 0.909.

Table 2

Reliability of Teachers' Survey Tool

Reliability Statistics	
Cronbach's Alpha	N of Items
.909	36

Data / Information Collection and Analysis Procedures

As explained earlier, this study consisted of two major methodologies; survey method and interview. Therefore, the study consisted of two different ways of data collection tools and techniques. At first, I present the data collection tool and techniques of the survey method, which followed the interview method.

While using the survey method, a well-structured survey questionnaire is required. So, in this study too, the numerical data were collected via questionnaires based on the classroom pedagogy in learning Geometry theorems. The questionnaires were designed in such a way so that they could address all kinds of possible factors responsible for Geometry learning investigated from the first phase study. Then, the reliability and validity of the questionnaires were checked by the subject experts and educators. Finally, the questionnaires were translated into the Nepali language too for a better understanding of the participants and collected the responses of both teachers and students in Google form through online mode.

After collecting the numerical data in the first phase, the researcher used the 25th version IBM Statistical Package for Social Sciences (SPSS) to draw the possibilities of the outcome of parametric and non-parametric tests. The descriptive statistics mean, percentage and different types of statistical tests (like T-test, ANOVA, and Correlation) were used to analyze the quantitative data in this study.

Along with the analysis of survey data, I analyzed the interview to verify the possible outcomes of the initial phase data. In the second phase of data collection, the researcher collected the experiences and their perceptions to address the second research question from the learners, teachers, educationists, and curriculum developers. The interviewed data were recorded through online mode in Google Meet and translated into words without losing its originality. Themes were formulated

based on the key points collected from the interviews and discussed with the support of the literature.

Likert Scale Measurement

This research study consisted of two different questionnaires to collect the quantitative data, one for the students and another for the teachers' purpose. Questionnaires for the students consisted of 39 statements whereas teachers' questionnaires consisted of 36 statements after the refinement of the pilot study. All the statements in both the questionnaires were divided into different subtopics like content, teaching-learning activities, school administration, evaluation techniques, and teachers' professional development. A five-point Likert scale was used to measure the perception and behaviour of teachers and students in this study. Likert scales were helpful in social sciences and research ventures which can provide "a range of responses to a statement or series of statements" (Croasmun & Ostrom, 2011, p.19). A Likert-type scale "requires an individual to respond to a series of statements by indicating whether he or she strongly agrees (SA), agrees (A), is undecided (U), disagrees (D), or strongly disagrees (SD). Each response is assigned a point value, and an individual's score is determined by adding the point values of all of the statements" (Gay, Mills, & Airasian, 2009, pp. 150- 151). The term undecided (U) is termed as neutral (N) in this research study. Each statement in the questionnaires was coded in a five-rating scale, strongly disagree, disagree, neutral, agree, and strongly agree to measure the perceptions of teachers and students on problems in learning geometry theorems in secondary schools. "The ordinal scale not only classifies but also introduces an order into the data. These might be rating scales where, for example, 'strongly agree' is stronger than 'agree'…" (Cohen et al., 2007, p. 502). After reading many kinds of literature and theories, the researcher came to know that Likert scale

measurement is more applicable for real-life researches which can measure delicate things like attitudes, behaviour, feelings, belief, and ideas, and so forth (Edmondson, 2005; Joshi, Kale et al., 2015; Park, 2005). Likert scale was applied as one of the most central and now and again utilized psychometric devices in educational and social sciences research (Joshi et al., 2015)

Regarding the rating of the Likert scale during data analysis "strongly disagree" was coded as "1" and "disagree" as "2". Similarly, the "neutral" option was used in the statement to indicate the neutral position of the participant in that particular item which was coded as "3". Likewise, "agree" and "strongly agree" are the fourth and fifth options in each statement which shows that the participants were in favour of the statements and coded as "4" and "5" during the analysis of data in SPSS. Normally, there were 5 categories of response ranging from 5 = strongly agree to 1 = strongly disagree with a 3 = neutral type of response (Jamieson, 2004). In the case of negative statements, the coding was reversed i.e. "strongly disagree" starting from "5" to "Strongly agree" equals to "1". This is because "strongly disagree" in the negative statement can give a positive sense.

Validity, Reliability, and Trustworthiness

The validity of an instrument is the degree to which the deliberate worth reflects the attributes it is expected to measure while reliability refers to the degree to which repeated measurement or measure taken under indistinguishable conditions will yield a similar outcome (Lewis, 1999). In this research study, to maintain validity, the researcher developed the questionnaires to find the factors affecting learning Geometry theorems in grade IX and X standard students. The prepared questionnaires were verified by the subject experts and teacher educators. Moreover, for the verification of those questionnaires, the researcher conducted a pilot testing in one of

the schools with 64 students besides the sample study. Similarly, the researcher took 20 teachers in the pilot study to finalize the teachers' questionnaires. The analysis of piloting data is kept above in this section.

In this study, the researcher established the content validity of the survey tool through the extensive review of the literature which contains all the domains of the instrument. Moreover, the researcher consulted with the subject experts of the related field as suggested by Lunenburg & Irby (2008) and made appropriate changes on the questionnaires based on their suggestions. Likewise, face validity of the instrument was ensured by consulting with the teachers and students in the pilot test on the accuracy and appropriateness of the questionnaire items and their relevance to the study purpose because it is the finest way to attain content validity (Muijs, 2004).

Similarly, criterion-related validity of the instrument was established by conducting a pilot test among the similar type of participants besides the sample population by using the instrument to calculate Cronbach alpha as suggested by Muijs (2004).

Finally, the researcher established the construct validity of the instrument used in the survey by establishing both validity of instrument; content and criterion-validity (Lunenburg & Irby, 2008), both of which were established by the researcher in the paragraphs above.

Similarly, reliability refers to the consistency of the research study. It means that the result concluded by this research study is nearly the same when it is used by different researchers. Creswell (2003) argued that validity refers to whether the instrument measures what it intends to measure. In quantitative research, it is very important to minimize the errors of the instrument that might arise from estimation issues in the research study (Bhattarai, 2015). To measure the consistency of the

questionnaire, Chronbach alpha was calculated on the survey outcomes of pilot testing.

For the second phase study, the researcher took trustworthiness as a quality standard. Bergman and Coxon (2006) argued, "quality concerns play a central role throughout all steps of the research process in qualitative methods, from the inception of research questions and data collection to the analysis and interpretation of research findings" (p. 1). Trustworthiness, in a qualitative study is about establishing the four things credibility, transferability, dependability as well as conformability" (Shenton, 2004, as cited in Manandhar 2018). To maintain the credibility in this study, the researcher took a prolonged engagement with the secondary level teachers to address the possible remedies which could overcome the problems found in the first phase study. While doing so, all participants had an equal chance to get involved in this study.

Similarly, the researcher maintained transferability in this study. For this, the researcher believed that the findings of this study could be useful for the other stakeholders related to a similar field. To maintain conformability, the researcher used the participants' responses without any biases. And finally, to maintain dependability, the researcher tried to maintain the consistency of the data and findings in this study.

Ethical Consideration

The matter of ethical consideration is very important in the research process. Every researcher should be aware of the ethical consideration while conducting any research studies. "Ethical issues may stem from the kind of problems investigated by social scientists and the method they use to obtain valid and reliable data" (Cohen, Manion & Morrision, 2007, p. 51). In this regard, the researcher needs to be aware that each stage in the research sequence raises ethical issues.

To maintain the ethical consideration in any mixed-method research, Manandhar (2018) argued, "ethical consideration constitutes sampling process, respect participants, inform consent, maintaining the privacy of every participant, use of language, etc." (p. 49). In this regard, I took permission from every respondent/ participant and the schools' administration before they participated in this study. I also explained the objectives and the purpose of my study before collecting any data. I was very conscious and respectful regarding my research participants in terms of their privacy, confidentiality, and professional ethics.

Similarly, none of the participants was forced physically or emotionally to be a part of this study. They were not harmed in any case while collecting the data and information. They were free to expose their views while responding to the research matter. The details of the participants and their views are kept confidential and pseudo-name is used instead of their original name in the necessary condition of the study. In the case of qualitative data, I provided a copy of their interview transcripts to the respondent teachers and students to improve their views if needed and assured them that their ideas were not violated, avoided, and modified.

The researcher respected the culture, language, social practices, and ethical issues of every participant in this study.

Chapter Summary

In this chapter, I discussed that the study was carried out using the sequential explanatory mixed-method to address the need for research questions mentioned in the chapter- I. Structured questionnaire with a five-point Likert scale was designed as a research tool for the quantitative data collection procedure. Pilot testing was done to maintain the reliability of the questionnaires in one of the schools of Budhanilakantha Municipality besides the sample schools of the same kind. The tool was finalized with

the analysis in SPSS and prolonged observations of the experts. Reliability and validity were ensured in the study. Ethical considerations were taken seriously in this research study. The quantitative data were gathered via survey method from 270 participants' students and 27 teachers of 6 different community high schools from Tokha Municipality, Kathmandu. Similarly, the qualitative data were collected from two students of secondary level, two teachers working at the same level, an educationist and a curriculum officer.

CHAPTER IV

EXPLORING THE PROBLEMS IN LEARNING GEOMETRY THEOREMS

This chapter aimed to serve the need of the first research question which begins with the analysis of students' responses data followed by teachers' responses data. Two hundred and seventy (270) students and twenty-seven (27) teachers from seven (7) different community schools of Tokha Municipality were participated in this survey and found that there is no missing data in their response. Furthermore, the research hypothesis for research question one is tested to present the result using appropriate statistical techniques. The responses are collected through students' and teachers' questionnaires which are analysed separately in the sections below. The analysis of the students' responses is followed by the analysis of teachers' responses.

Analysis of Students' Responses

The researcher has collected responses from 270 student participants on "Problems in learning Geometry theorems" through Google form and inserted the data in SPSS. For the analysis procedure, the researcher used some parametric and non-parametric tests which are discussed in this chapter.

In this section, the researcher analysed the data collected from the respondent based on mean and percentage. The researcher believes that this analysis helps him to find the factors affecting learning Geometry theorems. The researcher analysed each of the items based on the SPSS 25 output means and percentage of the respondent against each item. As the researcher has divided the instrument under four criteria which are the content related statement, teaching and learning activities related statement, statement related to school administration, and evaluation techniques related statements.

Firstly, the researcher analyses the items (see appendix B) under the content area followed by other components continuously. There are four (statements no. 1, 2, 4, and 6) positive and six (statement no. 3, 5, 7, 8, 9, 10) are negative in the structure under the content area. With the help of the responses collected from my respondent, the statement 'I can understand the terminologies used in geometry theorems' which is in one number of the research tool and positive in structure has the mean value of 3.64 where 64.07% (n = 173) of the total respondent are found agreed with the statement. As the average value of the statement is comparatively greater than 3, this suggests that most of the students understand the terminologies used in the geometry theorems, so it does not seem like a problem in learning geometry theorem.

Similarly, statement number two 'I can see the theorems are interconnected with one another' which is positive in structure has a mean value of 3.71 where 68.51% (n = 185) of the total respondent are found to agree with the statement. As the average value of the statement is comparatively greater than 3 and the percentage also shows that more than half of the sample agreed on this item. This suggests that a large number of students can see the connections with one another in geometry theorem and found it does not seem to be a problem in learning geometry theorems.

Likewise, the third statement 'I feel geometry theorems are more complicated than other content in mathematics' which is negative in structure has a mean value of 2.72 which is less than 3 and only 41.48% (n=112) of students have agreed with this statement which is less than half of the population. The result of this statement shows that they do not feel geometry theorems are more complicated than other content in Mathematics. This result also shows that this statement is not a problem in learning Geometry theorems in Mathematics.

In the case of the statement, 'I feel comfortable in proving geometry theorems experimentally' which is in the fourth number of the instrument and positive in structure has its mean value 3.53 which is slightly above 3, and found that 54.44% (n = 147) of students agreed which is above half shows that the high number of students prefer to prove Geometry theorems experimentally.

The statement 'I feel complicated to translate the word problems into the figure' which is in the fifth number in the instrument and negative in structure has a mean value of 2.74 which is comparatively less than 3 and 39.62% (n = 107) of students agreed with this statement. The majority of students (n = 94) put their views in a neutral position, and few (n = 69) have disagreed with this statement. This result shows that students do not feel complicated to translate the word problems into figures.

The statement 'I feel easy to prove geometry theorems when figures are given' which is in the sixth number of the survey tool and positive in structure has got 3.83 as the mean score which is comparatively above 3 and 69.63% (n = 188) of students agreed in this item. This result shows that the high number of students feel easy to prove Geometry theorems when figures are given.

The statement 'I feel geometry theorems are less practicable in our real-life' which is negative in structure and is in the seventh number in the survey tool and negative in structure has its mean value of 2.59 which is comparatively less than 3 and 46.29% (n = 125) students agreed. The number of students who are against i.e., disagrees with this statement is 19.62% (n = 53) and the remaining are neutral shows that students feel geometry theorems are less practicable in their real life.

The statement 'I see the less practical application of geometry theorems in future which less encourage me to learn it' has a mean value of 2.9 which is

comparatively less than 3 and 35.55% (n = 96) students agreed with it. This statement is in the eighth number of the instrument and negative in structure concludes that a high number of students are not in favour of the statement.

The statement 'I find the theorems are less connected with the knowledge obtained in the previous grade' is in the ninth number of the instrument and negative in structure has a mean of 3.2 which is slightly above 3 but only 23.33% (n = 63) of students agreed on this statement shows that majority of students find the theorems are connected with the knowledge obtained in the previous grade.

The statement 'I feel theoretical learning seems difficult than solving the problem in mathematics' which is the last (10^{th}) statement in the content area and negative in structure has to mean value of 2.7 which is comparatively less than 3 and found 44.81% (n = 121) of students agreed on it. Only 20% (n = 54) of students disagree with this statement shows that theoretical learning seems difficult than problem-solving in Geometry theorems.

Secondly, the researcher analysed the statements which are under teaching and learning activities. There are nine (statement no. 11, 13, 14, 15, 18, 20, 21, 22 and 23) positive statements and four (statement no. 12, 16, 17 and 19) negative statements in it. Statement no. eleven, 'Our classes of geometry begin in an interesting way' which is positive in structure has an average value of 3.59 which is comparatively above 3, and found as 60% (n = 162) of students agreed with it which is more than half of the sample. The result shows that a high number of students agreed that their class of Geometry starts interestingly.

Similarly, the statement 'I feel difficult to solve the geometry theorems without the help of the teacher' which is in the 12th number in the instrument and negative in structure has an average value of 2.68 which is comparatively below 3, and 41.11% (n

= 111) of students agreed in it. In this statement majority of the students (n = 104) put their views in a neutral position and very few (n = 55) are only against shows that this statement does not perfectly seem like the problem.

Likewise, the statement 'Our teacher uses ICT such as mobile, laptop, desktop computer, etc. to clarify geometry theorems' which is in the 13th number of the instrument and positive in structure has its mean value of 2.93 which is comparatively below 3 and 34.44% (n = 91) students only agreed in it. The result of this statement shows that their teachers use less ICT related materials in their classroom practice while teaching Geometry theorems.

The statement, 'Our teacher provide enough learning opportunity for all the students in our class' is in the 14th number of the survey instrument and positive in structure has the average value of 4.03 which is comparatively above 3 and 81.48% (n = 220) students agreed in it. The result in this statement shows that their teacher provides enough learning opportunities for them while teaching Geometry theorems. It does not seem like the problem in learning Geometry theorems in community schools.

The statement 'Our teacher provides extra similar problems related with the exercise while teaching theorems' which is in the 15th number of the survey instrument and positive in structure has an average value of 4.09 which is comparatively above 3 and 82.96% (224) students agreed in it which shows that their teachers provide them extra similar problems related with the exercise while teaching Geometry theorems. This result also shows that this statement does not seem like a problem in secondary schools.

The statement 'Our teacher less response to all the students in our class' which is in the 16th number of the survey tool and negative in structure has its average score

of 3.88 which is comparatively above 3 and 73.70% (n = 199) of students agreed with it. The result of this statement shows that the teachers less response to all the students in their class and it seems to be a problem in learning Geometry theorems in this context.

The statement 'I am afraid of asking questions with my teacher' which is in the 17th number in survey instrument and negative in structure has an average score of 3.54 which is comparatively above 3 and 17.40% (n = 47) of students agreed with it. In this statement, 77 students are in a neutral position and 146 (54.07%) students disagree. The result in this statement shows that the majority (more than half) of students are against the statement so the researcher found that students do not feel afraid to ask questions with their teachers. This statement does not seem a problem in this case.

The statement 'Our teacher focuses on group works while proving geometry theorems' which is in the 18th number of the survey tool and positive in structure has its average value of 2.97 which is comparatively below 3 and found that 26.60% (n = 72) only agreed with it. In this statement, 112 (41.48%) students are in a neutral position and 86 (31.85%) students disagree. The result in this statement shows that the secondary teachers in community schools less focus on group work while proving Geometry theorems. This statement seems a problem over here.

The statement 'I find that the teaching-learning materials used by my teacher are less effective in clarifying the concepts while proving theorems' which is in the 19th number of the survey tool and negative in structure has its mean value of 3.4 which is comparatively above 3 and found that only 19.25% (n=52) students agreed in it. As 133 (51.48%) students disagree with this statement seems that they found the teaching and learning material used by their teachers in teaching Geometry theorems

are enough in clarifying their concepts. In this scenario, this statement does not seem a problem in this context.

The positive structure statement 'Our teacher focuses more on theoretical proof than experimental verifications while proving geometry theorems' which is in the 20th number of the instrument which is used for collecting the responses from the students has an average value of 3.05 which is comparatively above 3 and found that only 19.45% (n = 72) students agreed in it. In this item, 135 (50%) students are in a neutral position shows that this statement does not perfectly seem like a problem.

The statement 'Our teacher provides more opportunity for low achieving students while proving theorems in the classroom' which is in the 21st number of the survey tool and positive in structure has an average value of 3.55 which is comparatively above 3 and found that 59.26% (n = 160) students agree in it. The result of this statement shows that the secondary Math teachers in this Municipality provide more opportunity for the low achieving students while proving Geometry theorems in classroom practices and does not seem a problem here.

The statement 'Our teacher focuses on our curiosity in learning geometry theorems' which is in the 22nd number of the instrument and positive in structure has its mean of 3.71 which is comparatively above 3 and found that 66.67% (n = 180) students agreed with it. The result of this statement shows that the teachers at this level of the community schools in Tokha focus on the curiosity of the students while teaching geometry theorems.

Statement 23 of the instrument which contains 'I feel easy to learn geometry theorems with my friends' is positive in structure has a mean score of 3.88 which is above 3 and found that 73.70% (n = 199) of students agreed with it. The result of this statement shows that the students feel more comfortable sharing their Geometry

theorems problem with their friends. Thirdly, the researcher analyses the statements which are under school administration. There are two (statement no. 24 and 25) positive statements and six (statement no. 26, 27, 28, 29, 30, and 31) negative statements in it. The statement 'We have good access of internet at our school to find the supportive materials for learning geometry theorems' which is in the 24th number of the instrument and positive in structure has the average of 3.17 which is comparatively above 3 and found that 42.22% (n = 114) students agreed in it which is less than half of the total students, so the results show that more than half from the sample students do not have internet access in their school to find the supportive material in learning Geometry theorems which seems a problem in this study.

The statement 'We have a facility of Math Lab at our school which supports us in learning geometry theorems' which is in the 25th number of the survey tool and positive in structure has the mean of 2.21 which is comparatively less than 3 and found that 11.11% (n = 30) students only agreed in this statement results that most of the schools do not have a facility of Math lab in their schools which supports in learning Geometry theorems. This statement seems to be a problem in this study.

The statement 'Because of maximum extra-curricular activities (like sports/ arts) in school, I am not able to attend the regular class of Mathematics' is the 26th statement in the survey tool and negative in structure has the mean value of 4.09 and found that 8.14% (n = 22) students only agree in it. The result in this statement shows that students do not want to accept that, they missed the class of Mathematics because of maximum extra-curricular activities. In this situation, this statement doesn't seem like the problem in this study.

Statement 'Our school education system focuses is only on the marks in the examination which motivates students in rote memorization of theorems without

understanding' is the 27th statement of my survey tool and negative in structure has the mean score of 3.03 which is slightly above 3 and found that 36.29% (n = 98) students only agreed with the statement. But this statement has got similar responses in all the category like neutral 22.69% (n = 62), disagree 40.74% (n = 110). In this scenario, this statement not perfectly seems like a problem.

The negative structured statement 'The division of section of our class is according to the student's achievements, and hence low achiever students get less support in learning theorems' is the 28th statement in the instrument which has an average of 3.5 which is above 3 and found that 20.37% (n = 55) only agree with the statement. In this statement, 54.81 (n = 148) students are against the statement or I can say they disagreed with this statement. The result of this statement shows that it is not a problem in this context.

The statement 'We feel difficult to actively participate in the classroom activities because of the maximum number of students' is in the 29th number in the survey instrument and negative in structure has the mean of 3.45 which is comparatively above 3 and found that 18.89% (n = 51) students only accept it. In this statement, 53.70% (n = 145) of students put their views on disagreeing which shows that they do not feel difficult to participate in the classroom activities because of the maximum number of students and this statement does not seem like the problem in this study.

Statement 'Manipulative geometrical materials (e.g., Charts, Solid materials, etc.) are less available in our school' is in 30th number in the survey tool and negative in structure has the mean of 3.14 which is comparatively above 3 and found that 28.51% (n = 77) students agreed with the statement. There are 42.59% (n = 115) students who disagree, and the remaining (n = 78) students are at the neutral position

seems that this statement is not a problem in this study and found that manipulative geometrical materials are enough available in the community schools.

Statement 'Students are less motivated as our school does not reward the high achiever in mathematics' is the 31st statement in the survey item and negative in structure has a mean of 3.08 in the response data which is comparatively above 3 and found that 27.41% (n = 74) students agreed in this statement. In this statement number of neutral students has more frequency i.e., 96 (35.56%) and the remaining (37.03%) have disagreed. The result shows that the number of disagreed is more than that of agreed but the overall results do not perfectly seem to be a problem in this area.

Finally, the researcher analyses the statements which are under evaluation techniques. There are six (statement no. 32, 33, 35, 36, 37, and 39) positive statements and two (statement no. 34 and 38) negative statements in it. The statement 'Our teacher checks our homework daily' is the 32nd statement in survey questionnaires and positive in structure has an average of 3.71 which is comparatively above 3 and found that 67.41% (n = 182) students agreed with this statement. The result of this statement shows that the teachers checked their homework daily and doesn't seem like a problem in this study.

The positive structured statement 'Our teacher provides regular feedback of our works related to learning geometry theorems' is the 33rd statement in the instrument having an average of 3.63 which is comparatively above 3 and found 62.22% (n = 168) students agreed with it. The result shows that the teachers provide regular feedback to the students in their work so, this statement doesn't seem to be a problem in this study.

The statement 'I feel difficulty in proving geometry theorems within the given time in the examination' is in 34th number of the instrument and negative in structure

has an average of 2.7 which is comparatively less than 3 and found that 45.19% (n = 122) students agreed with the statement. Only 27.41% (n = 74) of students disagreed with the statement shows that this statement is also not a problem in this study.

The statement 'Our teacher takes different types of test such as unit test, class tests, board tests, etc. except terminal examination' is the 35th statement in the survey tool and positive in structure has an average of 3.55 which is comparatively less than 3 and found that 57.78% (n = 156) students agreed in it. This result shows that the majority of the teachers take different types of tests except for terminal examination while teaching Geometry theorems at the secondary level and not found as a problem statement in this study.

Statement 36 which contains 'Our teacher provides us multiple ways of proving theorems as per our competency area after the class evaluation' is positive in structure has the mean value of 3.56 which is comparatively above 3 and found as 57.78% (n = 156) of students agreed with it. This result shows that the majority of the teachers provide multiple ways of proving Geometry theorems as per the students' competency areas and does not find this statement as the problem statement in this study.

Statement 37 which contains 'While proving geometry theorems, our teacher helps the low achiever students' is positive in structure has an average of 3.74 and found that 68.52% (n = 185) of students agreed with the statement and this statement also doesn't possess problem in learning Geometry theorems in this context.

The statement 'Our teacher focuses more on marks in the examination' is in the 38th number in the survey tool and negative in structure scored the average of 2.92 which is comparatively less than 3 and found that 37.78% (n = 102) students agreed with it. The responses in this statement are similar in structure like neutral = 29.26%

(n = 79), disagree = 32.96% (n = 89) results not perfectly seem like the problem in this study.

The statement 'The three hours' exam in Mathematics is not sufficient for me to prove geometry theorems on time' is in the 39th statement of the survey tool and positive in structure has an average of 3.1 which is slightly above 3 and found that 37.04% (n = 100) students agreed this statement and 30.74% (n = 83) students have disagreed the statement. Also, neutral = 32.22% (n = 87) shows that this statement does not perfectly seem like a problem in this study.

Exploring the Major Problems and its Discussion

Geometry is considered a difficult portion of Mathematics by most of the students due to aversive teaching style, difficulty in following the instructions, difficulty in understanding the terminologies and the statements, difficulty in learning the ways of proving theorems, and ways to solve a problem. Similar reasons are explored by this study from the statistical analysis of students' responses collected through a survey which are discussed in the section below.

Firstly, the researcher found that the students feel Geometry theorems are less practicable in their real-life (Luitel, 2003, Pant, 2017, Shrestha, 2019). Similarly, theoretical learning seems difficult than solving problems in Mathematics.

Likewise, the use of computer and technology has become fundamental to the operation of organization and society (Kroeker, 2010; Yonck, 2010) but it is also found that teachers use fewer ICT tools such as mobile, laptop, desktop computer, etc. to clarify geometry concepts while teaching Geometry which creates problems in learning theorems. Many researchers like Saha et al. (2010), Kurtulus and Uygan (2010), Majerek (2014), Oktavigyanthi and Supriani (2015), Belghesi and Kamalludeen (2018) have concluded with the positive impact of ICT in learning

Mathematics. As communication to students can provide an effective way to prove and proving in Geometry (Villiers, 1999) but it is found that teachers are less responding to all the students in Mathematics class and also focus less on group work while proving Geometry theorems which is creating problems in theorems learning. "Van Hieles believed that cognitive progress in geometry can be accelerated by instruction" (Vojkuvkova, 2012, p. 74) but the less response by the teachers to all the students in Geometry is creating problems for them in theorem learning. Students' do not have good access to the internet and Math lab in their schools which can support visualization and clarify the geometrical concepts and contribute to theorems learning. A study by Fabiyi (2017) has also concluded that "unavailability of instructional materials/ insufficient time allocation" (p. 88) are the major reasons behind the difficulty faced by the secondary students in Geometry learning. It is also found that students feel easy to learn Geometry theorems from their friends which indicates that they feel less comfortable to learn and share their problems with their teacher.

Inferential Statistical Analysis

This section in this study contains the statistical tests on the surveyed data by using SPSS 25. Firstly, some assumptions are made to apply the parametric tests which are followed by the statistical analysis.

Assumptions for Numerical tests

The purpose of this research is to find the problem in learning Geometry theorems. To serve the purpose of this study, the researcher performs parametric and non-parametric tests in the obtained data. Firstly, the researcher wants to use the parametric tests if it meets the necessary assumptions, if not the researcher can perform non-parametric tests. Most of the researchers often use parametric test in their research rather than non-parametric because it is considered as the more

powerful test in comparison to the latter because of its mathematical underpinning logic (Cohen et al., 2018). According to Heiman (2011), there are two common specific assumptions for all parametric tests; first, the data should be interval or scale and second, it should be normally distributed. The researcher used SPSS 25 for the testing of these criteria to perform parametric tests on the obtained data from the survey. Once the data satisfy the criteria for the parametric test then the researcher can use a non-parametric test too in the sense that "it is possible to apply non-parametric statistics to parametric data" (Cohen et al., 2007, p. 503)

Interval Data

This assumption for the parametric test suggests that the data must be at the interval scale for the numerical analysis in a quantitative study. The researcher combines the Likert items to create new scale data for the analysis of students' perception in Geometry learning because "nominal and ordinal data are considered to be non-parametric, while interval and ratio data are considered to be parametric" (Cohen et al., 2007, p. 503). Hence, the data of this study meets this assumption successively.

Normal Distribution

This assumption for the data analysis states that the data should be normally distributed to perform a parametric test. It is used to determine whether sample data has been drawn from a normally distributed population. To meet this assumption, the researcher has performed different types of tests like histogram, skewness, and kurtosis, etc. The histogram is used to determine the normality of variables through the figure as "histograms are useful for presenting continuous data" (Cohen, et. al, p.507). To examine the normality of the data through this method, most of the part of

the histogram should lie inside the normal curve. The normality of the variables is shown in the figure below.

Histogram

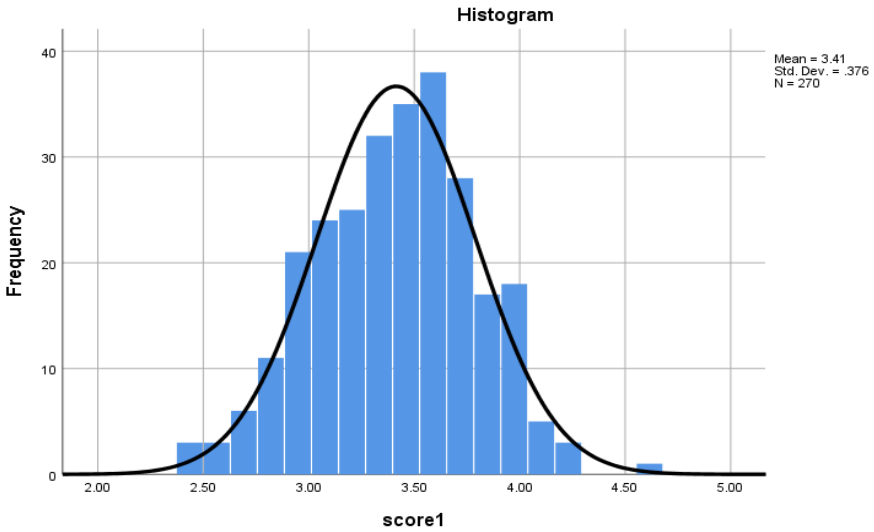

Figure 9: Normal Curve of Students' Perception

The figure above clearly shows that most of the data are inside the normal curve. The normal distribution is always symmetrical about the mean which looks like a bell curve and it can be seen very clearly in the above diagram. Therefore, the data obtained from the student's survey tool is normally distributed.

Moreover, the researcher performs the second test to know the normality of the data by using the absolute value of the skewness and kurtosis. While performing the normality criteria in this process, the researcher finds the absolute value is less than 1 (see table: 3) which suggests that the data is normally distributed. Besides, the researcher also extends the inspection of normality to include a measure of kurtosis and skewness were between twice the standard error which is accepted as normal (Cohen et. al, 2018). From the table below (Table: 3) the standard error of skewness is 0.148 then the range of acceptable skewness is between -0.296 to +0.296. Since the skewness of the data is -0.107 which falls in the acceptable range. The same procedure is adopted for the calculation on acceptably 'normal' degree of kurtosis, the

researcher doubled the standard error of kurtosis which is 0.295 and found the acceptable range of -0.59 to +0.59 which contains the value of kurtosis i.e., -0.263. Hence from this observation, the researcher concluded that the collected data from the students' questionnaire is normally distributed.

Table 3

Calculation of Skewness and Kurtosis on students' response

N			Std.		Std.
Valid	Missing	Skewness	Error of Skewness	Kurtosis	Error of Kurtosis
270	0	-.107	.148	-.263	.295

Similarly, the researcher performs another test to confirm the normality of the data and that is the Shapiro-Wilk test for the normality. The table below (Table: 4) shows that the p-value is 0.381 which is above 0.05 which is acceptable for the normality criteria as if the p-value were below 0.05 then it would violate the assumptions of normality of the data. In terms of the Shapiro-Wilk test, the researcher has got that his data is approximately normally distributed.

Table 4

Calculation of Shapiro-Wilk test on students' responses

	Shapiro-Wilk		
	Statistic	df	Sig.
Average of the total score	.994	270	.381

From the above assumptions and tests for the interval/ scale data, normality test and Shapiro-Wilk test the researcher found that he can use parametric tests as per the necessity. The term ‘total score’ in the table above is the sum of the average of the responses of each student.

Analysis and Interpretation of Inferential Statistics

Both descriptive and inferential statistical analyses were performed during the analysis of survey data. The researcher used an independent sample t-test and Correlation for the analysis procedure of students' data.

Comparing Problems Faced by the Students Based on Their Gender

To examine the significant difference between groups of independent variables such as Gender, the researcher used an independent sample t-test. "The t-test is used to discover whether there are statistically significant differences between the means of two groups" (Cohen et al., 2018, p. 777). The researcher applied a t-test to compare the problems faced by the students while learning geometry theorems based on their gender.

The result has been presented in the table below:

Null Hypothesis: There is no significant difference between the gender of students and learning Geometry theorems.

Table 5

Independent Sample t-test on Students’ Response Based on Their Gender

		T	df	Sig. (2-tailed)
Average of the total score	Equal variances assumed	-1.627	268	0.105
	Equal variances not assumed	-1.639	266.673	0.102

The table above shows that t = -1.627, df = 268, p = 0.105 > α = 0.05 which indicates that there is no significant difference in the responses on the problems faced by the secondary students of Tokha Municipality based on their gender. The mean value of male students is 3.3788 and that of the female is 3.4532 which also shows that their mean responses are approximately equal and do not show any significant differences. Alex and Mammen (2014) also found no significant statistical difference between the genders in Geometry performance with secondary school learners in their research study.

Comparing Problems Faced by the Students Based on Their Grades

Similarly, the researcher performs the independent sample t-test on students' responses based on their Grade (Grade IX and X). The null hypothesis and the SPSS output with its interpretation in presented below.

Null Hypothesis: There is no significant difference in learning Geometry theorems based on the students' Grade.

Table 6

Independent Sample t-test on Students' Responses on the Basis of Their Grade

		T	df	Sig. (2-tailed)
Average of the total score	Equal variances assumed	-2.858	268	0.005
	Equal variances not assumed	-2.845	250.433	0.005

The table above shows that $t = -2.858$, $df = 268$, $p = 0.005 < \alpha = 0.05$ (p-value is greater than confidence level) which indicates that there is a significant difference in the responses to the problem faced by the secondary students based on their Grades. This analysis shows that it rejects the null hypothesis and accepts the alternate hypothesis i.e., there is a significant difference in the problem faced by the secondary students on Geometry theorems based on their Grades.

Correlation Analysis

The researcher tested the five hypotheses (Hypothesis 3 to hypothesis 7) of the study by using Pearson-product moment correlation. The SPSS analysis output and interpretation of the analysis are presented below.

The relationship between the content of Geometry and teaching-learning activities

Null Hypothesis: There is no relationship between problems in content of Geometry and teaching-learning activities in geometry theorems learning.

Correlation among criteria (i.e., Content, Teaching Learning Activities, School Administration and Evaluation) on Teacher Perceptions in learning Geometry theorems.

The relationship among the learning criteria set by the researcher i.e., content, teaching-learning activities, school administration, and evaluation techniques in learning Geometry theorems was investigated using the Pearson-product moment correlation coefficient and presented below.

Table 7

Pearson-product Moment Correlation between the Content of Geometry and Teaching-learning Activity

		Content	Teaching Learning
Content	Pearson Correlation	1	.346**
	Sig. (2-tailed)		.000
	N	270	270
Teaching Learning Activity	Pearson Correlation	.346**	1
	Sig. (2-tailed)	.000	
	N	270	270

**. Correlation is significant at the 0.01 level (2-tailed).

From the SPSS output table, the researcher has got that the relation between two variables i.e., content and teaching-learning activities are, $r = 0.346$, $n = 270$, $p < 0.01$, and found a very slightly positive relationship between them. The result shows that the role of content in teaching-learning activities is less connected in learning Geometry theorems at the secondary level and they may be statistically significant (Cohen et al., 2018).

The relationship between problems in content of Geometry and evaluation techniques

Null Hypothesis: There is no relationship between problems in the content of Geometry and evaluation techniques in Geometry theorems learning.

Table 8

Pearson-product Moment Correlation between the Content of Geometry and Evaluation Techniques

		Content	Evaluate
Content	Pearson Correlation	1	.116
	Sig. (2-tailed)		.057
	N	270	270
Evaluate	Pearson Correlation	.116	1
	Sig. (2-tailed)	.057	
	N	270	270

Similarly, there is a very weak positive correlation between two variables content and evaluation techniques $r = 0.116$, $n = 270$, $p > 0.01$ the result shows that the relation between these two variables is very low in problems in learning Geometry theorems. The value of $p = 0.057 > 0.001$ shows that the variables are not statistically significant (Cohen, et. al, 2018).

The relationship between teaching-learning activities and school administration

Null Hypothesis: There is no relationship between problems in teaching-learning activities and school administration in learning Geometry theorems.

Table 9

Pearson-product Moment Correlation between Teaching-learning Activities and School Administration

		Teaching Learning	School Admin
Teaching Learning	Pearson Correlation	1	.556**
	Sig. (2-tailed)		.000
	N	270	270
School Admin	Pearson Correlation	.556**	1
	Sig. (2-tailed)	.000	
	N	270	270

**. Correlation is significant at the 0.01 level (2-tailed).

Likewise, there is a moderate relationship established $r = 0.556$, $n = 270$, $p < 0.01$ between teaching-learning activities and school administration. The result shows that school administration is also responsible for teaching-learning activities in creating problems in learning Geometry theorems.

The relationship between teaching-learning activities and evaluation techniques

Null Hypothesis: There is no relationship between problems in teaching-learning activities and evaluation techniques in learning Geometry theorems.

Table 10

Pearson-product Moment Correlation between Teaching-learning Activities and Evaluation Techniques

		Teaching Learning	Evaluate
Teaching Learning	Pearson Correlation	1	.542**
	Sig. (2-tailed)		.000
	N	270	270
Evaluate	Pearson Correlation	.542**	1
	Sig. (2-tailed)	.000	
	N	270	270

**. Correlation is significant at the 0.01 level (2-tailed).

Same like in the previous paragraph as I have discussed I too found here the moderate relationship $r = 0.542$, $n = 270$, $p < 0.01$ between teaching-learning activities and evaluation techniques in learning Geometry theorems.

The relationship between school administration and evaluation techniques

Null Hypothesis: There is no relationship between problems in school administration and evaluation techniques in learning Geometry theorems.

Table 11

Pearson-product Moment Correlation between school Administration and Evaluation Techniques

		School Admin	Evaluate
School Admin	Pearson Correlation	1	.406**
	Sig. (2-tailed)		.000
	N	270	270
Evaluate	Pearson Correlation	.406**	1
	Sig. (2-tailed)	.000	
	N	270	270

**. Correlation is significant at the 0.01 level (2-tailed).

Finally, the researcher found r = 0.406, n = 270, p < 0.01 as a moderate correlation for the fifth hypothesis. This result shows that the variables 'school administration' and 'evaluation techniques' are statistically significant beyond the 1 percent level (Cohen et al., 2018).

Discussion on hypothesis result of students' responses

From the statistical analysis of students' responses, the researcher has concluded some remarks. By using an independent sample t-test, it is found that there is no significant difference in their response to the difficulty in learning geometry theorems based on their genders. Similarly, it is found that there is a significant difference in difficulty faced by the students in learning geometry theorems based on their grades.

Likewise, the correlation analysis shows that the correlation between the content of geometry and teaching-learning activity is slightly positive and the content of geometry and evaluation technique has a very weak positive correlation. The analysis also shows that there is a moderate correlation between teaching-learning activity and school administration. Similarly, the analysis also shows the moderate relationship between teaching-learning activity and evaluation techniques. Finally, the researcher has got a moderate correlation between school administration and evaluation techniques from the analysis of students' responses.

Analysis of Teachers Responses

In this section, the researcher had analysed the data collected from the respondent teachers. The researcher had addressed the perception of all the secondary Mathematics teachers who are working in the community schools of Tokha Municipality. To serve the purpose of this study the researcher had conducted different types of tests in this chapter on the collected data. The researcher believes that this analysis helps him to find the factors affecting learning Geometry theorems. The researcher analysed each statement by using mean, percentage, ANOVA (Analysis of Variance) on the SPSS outputs. As the students' survey tool, the researcher has divided the instrument into four criteria and they are, content, teaching-learning activities, school administration, and teachers' professional development (see appendix B).

The first criteria in this survey instrument are the content area which contains nine statements. Among the nine statements, there are four (statements no. 1, 4, 6, and 8) positive structured and five (statements no. 2, 3, 5, 7, and 9) negative structured statements. With the help of responses collected from the respondent teachers, the first statement 'my students can understand the terminologies used in geometry

theorems' which is positive in structure has a mean value of 3.96 which is comparatively above 3 and 88.89% of the total respondent teachers are found agreed with the statement. This result in this statement suggested that most of the teachers are in favour of this item and found that it doesn't seem like a problem in learning Geometry theorems.

Similarly, statement numbered two 'students feel difficult to find the connection between the theorems' which is negative in structure has the mean value of 2.15 where 77.78% of teachers agreed on it. The result in this item shows that students feel difficult to find the connections between the theorems and found that this item seems like a problem in learning Geometry theorems.

Likewise, the statement 'Students feel that geometry theorems are more complicated than other content in mathematics' which is in the third number of the instrument and negative in structure has its mean of 1.78 which is comparatively less than 3, and negative in structured where 77.78% of teachers agreed in this item. From this information I got, 'teachers believe that the students feel Geometry theorems are more complicated than other content in Mathematics' and it seems like a problem in learning Geometry theorems.

In the same way, the statement 'Students feel comfortable in proving geometry theorems experimentally' which is in the fourth number of the survey tool and positive in structured has its average score of 4.26 which is comparatively above 3, and found that 96.29% of teachers agreed in it. The result of this statement shows that most of the students feel comfortable in proving Geometry theorems experimentally than theoretically.

Similarly, the fifth statement of the instrument which consists of 'Students feel complicated to translate the word problems into the figure' and negative in structured

has a mean value of 1.59 which is comparatively less than 3, and found that 92.59% of the teachers agreed in it. The result of this item shows that students feel complicated to translate the words into figures which possess a problem in proving Geometry theorems.

Statement 'Students feel easy to prove geometry theorems when figures are given' which is in the sixth number of the instrument and positive in structure has its mean value 3.93 which is comparatively above 3 and 85.19% of the participant-teachers agreed in it. The output of this item shows that majority of the teachers believed that students feel easy to prove Geometry theorems when figures are given.

Statement 'Students feel that geometry theorems are less practicable in their real-life' has got the mean value of 1.67 which is comparatively less than 3 and found that 85.19% of teachers agreed with it. The result of this statement which is in the seventh number of the instrument and negative in structure shows that most of the teachers believe their students do not feel the Geometry theorems are practicable in their real life.

Statement 'Students feel easy while proving geometry theorems theoretically' which is in the eighth number of the survey instrument and positive in structure has an average score of 2.67 which is slightly less than 3 and positive in structured. The result of the responses shows that 22.22% of respondent teachers are only agreed with the statement which presents that most of the teachers believe that their students do not feel easy in proving Geometry theorems theoretically. It shows that learning the Geometry theorem theoretically seems like a problem here.

The statement 'I find the theorems are less connected with the knowledge obtained in previous grades' which is in the ninth number of the survey tool and negative in structure has its average score of exactly 3 and 51.85% of teachers agreed

with it and the remaining (48.15%) teachers disagreed. The result of this statement shows that this item does not seem perfect problem here.

The second criteria in this survey tool are 'teaching-learning activities' which contains fifteen statements. Among the fifteen statements eleven (statement no. 10, 13, 15, 16, 17, 18, 19, 20, 21, 22 and 23) are positive in structure and four (statement no. 11, 12, 14 and 24) are negative in structure. The tenth statement, 'The poor foundation of students in basic level mathematics poses problems in learning geometry theorems' which is positive in structure has an average score of 4.37 which is comparatively above 3, and 96.30% of teachers are agreed with it. The result of this item shows that the statement seems like a problem in learning Geometry theorems in secondary schools.

Similarly, the statement 'Students feel difficult to solve the geometry theorems without the guidance of teacher' which is in the eleventh number in the survey tool and negative in structure has an average score of 1.67 in the responses is agreed by 96.30% of teachers. The result of this item shows that most of the students feel difficult to solve the Geometry theorems without the guidance of the teacher.

Statement numbered twelve which contain 'Geometry theorems in mathematics less match with the interest of students' and negative in structured has got an average score of 1.85 and found that 74.07% respondent agreed in it. This result shows that Geometry theorems are less match with students' interest and found this as the problem in learning Geometry theorems.

Likewise, the thirteenth statement of the survey tool which is 'I use ICT tools in teaching geometry theorems' which is positive in structure has a mean score of 3.3 which is comparatively above 3, and positive in structured if found to be agreed by 59.26% of teachers in community schools. The result shows that more than half of the

teachers use ICT in their Geometry classes, but still nearly half of the teachers are not using ICT in their classrooms while teaching Geometry theorems.

Statement 'Student has psychological fear of the topic Geometry theorems' which is in fourteen number of the survey tool and negative in structure has the mean value of 2.15 and found that 77.78% of respondent teachers agreed in it. The result shows that this item seems like the problem in learning Geometry theorems.

The statement 'Because of students fewer practice results in poor performance in learning geometry theorems' which is in the fifteenth number of the instrument and positive in structure has the mean value of 4.19 and 81.48% of the teachers agreed with it. The result shows that statement numbered fifteen seems like a problem in learning Geometry theorems.

The statement, 'I can easily complete teaching Geometry content in the mentioned time' has got the mean score of 3.74 which is comparatively above 3. This statement which is in the sixteenth number of the survey instrument and positive in structure is agreed by 70.37% of the respondent teachers and seems like a problem in learning Geometry theorems.

Likewise, the statement 'I think the content of Geometry is more than the student's ability' which is in the seventeenth number of the survey tool and positive in structure has the mean value of 2.89 which is comparatively less than 3 and found that 37.04% of teachers only agreed in it. Most of the teachers disagreed with this statement shows that the content of Geometry is not more than the students' ability in secondary level and doesn't seem like the problem in learning Geometry theorems.

Similarly, the statement 'I can check all the homework copies of my students after completing each exercise' which is in eighteen number of the survey instrument and positive in structure has the mean value of 3.89 which is comparatively above 3

and found that 81.48% of teachers agreed with it. The result of this item shows that majority of the teachers can check students' work after completing each exercise and doesn't seem like a problem in learning Geometry theorems.

The statement 'I can provide feedback for all the students individually' which is in the nineteenth number of the instrument and positive in structure has a mean score of 3.93 and found that 77.78% of teachers agreed with it. The result of this item shows that this statement doesn't seem like a problem in learning Geometry theorems.

The statement, 'I focus more for the high achieving students while teaching geometry theorems' which is in the twentieth number of the survey tool and positive in structure has its mean value of 4.15 which is comparatively above 3, and found that 29.63% of teachers only agreed with it and the majority are in favour of disagreeing shows that teachers do not focus only on high achieving students while teaching Geometry theorems and doesn't seem to be a problem in this context.

The statement 'I encourage students to participate in a group discussion while proving geometry theorems' which is in the 21st number of the instrument and positive in structure has the mean value of 4.15 which is comparatively above 3 and the item is positive in structured. In this statement, 77.78% of the respondent teacher are agreed and found that most of the teachers focused more on group discussion while learning Geometry theorems which doesn't seem like a problem in this context.

Statement 22nd which represents the positive item 'I feel easy to teach geometry theorems' has scored the mean value of 3.93 which is comparatively above 3 and found that 85.19% of the teachers agreed with it. The result of this statement shows that teachers do not feel difficult while teaching Geometry theorems and doesn't seem like a problem in this study.

The statement 'I think the use of appropriate ICT tools helps students learn the concepts of geometry theorems' which is in the 23rd number of the survey tool and positive in structure has an average score of 4.15 and found that 77.78% of teachers agreed with it. The numerical output of this item shows that teachers believe in the use of ICT tools in helping to clear the concepts of Geometry theorems.

The statement, 'Most of the student prefer to leave some parts of geometry assuming that does not affect their letter grading in examination' which is in the 24th number of the survey tool and negative in structure has scored the average score of 2.19 and found that 81.48% of the teachers agreed in it. The output result shows that most of the students leave the Geometry theorems in examination by assuming that it doesn't affect their letter Grading (like if any student leaves one or two theorems in the exam and done other section correct then also, he/she may achieve the highest letter grade). This item in this context is found as the problem in learning Geometry theorems.

The third criteria in the teachers' survey tool are 'School Administration' which contains six (no. 25 - 30) statements. Among them, there are two (statement no. 25 and 26) positive statements and four (statement 27, 28, 29, and 30) negative statements in structure. The statement 'I use the internet to search the supportive materials for teaching geometry theorems' which is in 25th number of the survey tool and positive in structure has its average score of 3.85 which is comparatively above 3 and found that 77.78% of the teachers agreed with it. The result shows that many of the teachers use the internet to search the supportive materials for them in teaching Geometry theorems does not seem like a problem.

The statement 'I use math lab to supports students in learning geometry theorems' which is in the 26th number of the survey tool and positive in structure has

a mean score of 3.3 which is comparatively above 3 and found that 51.85% of teachers agreed with it. The result of this item shows that around half of the teachers use Math lab while teaching Geometry theorems and does not seems perfectively a problem in this context.

Statement 'Our school education system mainly focuses on the scores in the examination that motivate students for rote memorization of theorems' which represents the twenty-seventh statement in the survey tool and negative in structure has the mean score of 2.07 which is comparatively below 3 and found that 85.16% of the teachers agreed in it. The result of this item shows that the focus of most of the schools is towards the scores/ grades of the examination which motivates students in rote memorization and seems like a problem in this context.

Similarly, the statement 'Students do not get the opportunity of sufficient discussion because of many students in the classroom' which is in the twenty-eighth number of the instrument and negative in structure has its average value of 2.56 which is comparatively less than 3, and found that 59.26% of the respondent teachers agreed in it. The result of this item shows that more than half of the teachers found their class with the bulk of students which does not let them insufficient discussion on the subject matters. This statement also seems like a problem in this situation.

Statement 'Manipulative geometrical materials are less available in our school' which represents the twenty-ninth number of the survey tool and negative in structure has its mean score of 2.15 which is comparatively less than 3 and found that 81.48% of the teachers agreed in it. The result in this item shows that most of the schools lack sufficient manipulative geometrical materials to teach Geometry theorems and seems like a problem in this context.

Likewise, the thirtieth item of the tool which contains 'Students are less motivated as our school does not reward the high achiever in mathematics' is negative in structure has scored the average score of 2.63 which is comparatively less than 3, and found that 48.15% of teachers are only agreed in it. The result shows that the number of teachers in 'agree' and 'disagree' are almost similar so, this item doesn't seem perfectly a problem.

Finally, the last criteria in the teachers' survey tool are 'Teacher professional development' which contains six (no. 31-36) statements, in which one statement (no. 31) is positive in structure whereas five (statement no. 32, 33, 34, 35 and 36) are negative in structured. The statement 'I am teaching geometry theorems in the same way as I have learned' which is in the thirty-first number of the instrument and positive in structured has its average score of 2.96 and found that 40.74% of the teachers agreed with it. The result shows that more than half of the teachers have modified their ways of teaching according to the time and context so, this item doesn't seem like a problem in learning Geometry theorems.

The statement 'I have not got effective training to teach geometry theorems' which is in thirty-second of the instrument and negative in structured has its average score of 2.37 which is comparatively below 3 and found that 66.67% of respondent teachers agreed with it. The result shows that more than half of the teachers have not got effective training to teach Geometry theorems and only less than half of the teachers have got effective skills in the discussed topic. This numerical output shows that this item seems like a problem in learning Geometry theorems.

The statement 'I am less familiar with the ICT tools which can be used to teach geometry theorems' which is in thirty-three number of the survey tool and negative in structured has an average value of 2.67 which is comparatively less than 3 and found

that 59.26% of the respondent teachers agreed in it. The result shows that majority of the teachers are less familiar with the ICT tools which can be used in teaching Geometry theorems and seems like a problem in this study.

The statement 'I feel more comfortable in teaching other areas of mathematics than geometry theorems' which is in thirty-four number of the survey tool and negative in structure has its average score of 2.89 which is comparatively below 3 and found that 51.85% of the respondent teachers are agreed with it. The result of this item shows that more than half of the teachers feel comfortable teaching other content of Mathematics than Geometry theorems whereas nearly half of the teachers put their views against this item shows that this statement does not perfectly seem like a problem in teaching Geometry theorems.

The statement 'The training I have gained are not sufficient in teaching geometry theorems' which is in thirty-five number of the survey tool and negative in structure has its mean score of 2.63 which is comparatively less than 3 and found that 59.26% of teachers agreed in it. The result of this item shows that more than half of the teachers found their training is not sufficient for them to teach Geometry theorems effectively. The number of teachers who are against this statement is also nearly half which shows that this item doesn't seem perfectively a problem.

Lastly, the final statement of this survey tool which is 'I am not updated with the recent ideas in geometry so, I feel difficult to guide my students in it' is negative in structure has its average score of 3.56 which is comparatively above 3, and found that 14.81% of the teachers agreed in it whereas 59.26% of teachers disagreed in it, remaining teachers put their views in the neutral position. The result of this item shows that a higher number of teachers are updated with the recent ideas in teaching

Geometry theorems which indicates that this item doesn't seem like a problem in learning Geometry theorems.

Summary and Discussion of the Teachers' Outputs

After analysing the responses collected from the Mathematics teachers of secondary level in SPSS the researcher had concluded some remarks which are discussed in the following paragraphs.

It has been found that secondary level students have psychological fear of the topic "Geometry theorems". The symptoms of physiological fear such as sweaty, shivers, physical tense, impatient, etc. appeared among students when the subjects connected the element of proof in the theorem in geometry (Ni'mah, Susanto, Sunardi & Hobri, 2020). There could be various reasons for the psychological fear, but the researcher has pointed out mainly three reasons. The poor foundation of students in basic level mathematics (Amazigo, 2000; Adolphus, 2011; Ni'mah et al., 2020), less practice of geometry by students (Adolphus, 2011), and teachers' method of teaching (Fabiyi, 2017).

Mathematics teaching is done with traditional chalk and talk (Sharma, 2016; Mainali & Key, 2012) without the use of local teaching materials, manipulative and ICT tools (Panthi & Belbase, 2017). Teachers feel lazy to prepare and use local materials. Schools also lack the manipulative for geometry teaching. Many schools are not in access to ICT tools, accessories, and internet connectivity (Panthi & Belbase, 2017). According to Wagley and Jha (2013), even the Ministry of Education (MOE) of Nepal does not have a concrete micro-level policy regarding how to support schools and teachers in the implementation of ICT in classroom teaching and

learning integrated with mathematics. Mathematics teachers are less familiar with the ICT tools which can be used in geometry teaching. Panta and Dhakal (2015) argue that many mathematics teachers use computer technology for general personal use only and there is no concrete effort to help them in technology integration in mathematics education. It has been found that due to lack of use of local materials, manipulation (Mason, 2002; Uduosoro, 2011 as cited in Fabiyi, 2017), and the less or no use of ICT tools in geometry teaching, students feel difficulty in the visualization and learning the geometrical concepts.

The mathematics curriculum of Nepal is prepared by Curriculum Development Centre (CDC) without the involvement of teachers and students in a conventional way and prescribed to school and school teachers to implement (Luitel, 2020). The conventional approach of curriculum design and development process has made the mathematics curriculum culturally decontextualized (Luitel, 2018 as cited in Luitel, 2020). This study has also found that school-level mathematics is less related to the daily life of the students. Likewise, secondary level geometry seems detached from a real-life situation. As a result, students feel geometry, and especially geometry theorems are less practicable with their regular day to day life. So, the geometry theorems in mathematics less match with the interest of students. Due to the lack of interest, many students do less practice of geometry theorems.

In Nepal, teaching and learning of mathematics are focused on passing the exam (Pokhrel, 2018). The nature of mathematics exam is a three-hour written test which focuses on algorithm only. So, many mathematics teachers promote steps and algorithms in mathematics teaching.

Activities based teaching instruction is a new approach in Nepal that is based on Dewey's progressivism. It strengthens and deepens the mathematical knowledge of

students. However, this study has noted that activities-based geometry teaching is less followed by teachers.

According to Vygotsky (1987), learning takes place in a social setting when individuals get involved in the interaction and discussion (as cited in Dahal, Luitel & pant, 2019). Communication is a fundamental component in the mathematics classroom that enhances the analytical thinking and reasoning of students (NCTM, 2000). Despite the importance of communication in mathematics, due to many students in the classrooms, students are not getting the opportunity of sufficient discussion and practice of geometry theorems inside the classroom which has ultimately reduced their performance in geometry theorems.

Geometry is one of the topics among the abstract and complex aspects of mathematics that students find difficult to learn (Akinlade, 2004 as cited in Fabiyi). Geometry consists of many theorems that are kept in a certain order in the textbook based on their connection (Chou, 1988). But students feel difficult to find the connection between the succeeding theorems with the preceding theorems. As the geometry theorems are to be proved with a correct figure by the appropriate use of statements and reasons, students feel geometry theorems are more complicated than other content in mathematics. During the research study, it has been noted that many secondary level students lack reasoning skills in geometry and geometric language comprehension (Fabiyi, 2017). They feel complications in translating the word problems into the figures. As a result, they seek the guidance of their teachers to solve the geometry theorems.

During the research study, it has also been seen a few talented, self-motivated, and mathematically gifted students feel the theoretical proof of geometry theorems

easy. On the other hand, the study has found that for the average and fewer achievers, the theoretical proof is harder as compared to experimental verifications.

Our school education system mainly focused on the scores in the examination. Examination-driven instructional approach emphasizing knowledge of facts and standard methods through drill-and-practice is still dominant in Nepalese high schools (Mainali & Heck, 2017). Even the students just memorizing and writing the proof of the theorems in their exam sheets without understanding the proper logic and concepts can secure full marks. It has motivated students to rote memorization of theorems. This study has also found that after the use of the grading system in SLC/SEE some of the students have developed thinking that even if they leave a few questions their grading remains unaltered. It has negatively motivated some of the students to leave some parts of geometry including geometry theorems in the examination.

Assumptions of Numerical Tests

Same as in the analysis of students' responses the researcher tried to fulfil some assumptions to use parametric tests. Here also, the researcher took account of the assumptions suggested by Heiman (2011) for the use of parametric tests. Once the responses data satisfy the assumptions then the researcher performs the parametric and non-parametric test with the help of SPSS outputs.

Interval Data

To fulfil this assumption the researcher combined the Likert items score to get the new scale data because "interval and ratio data are considered to be parametric" (Cohen et al., 2007, p. 503). Therefore, the data of this study meets this assumption successfully.

Normal Distribution

As I discussed in the previous section, this assumption for the parametric tests requires normally distributed data for the analysis procedures. This assumption can clarify whether the sample data has been drawn from a normally distributed population or not. To meet this assumption the researcher has performed different types of tests like histogram, skewness and kurtosis test, Shapiro-Wilk test for the normality, etc. Firstly, the researcher used a histogram to investigate the normality of the data.

Histogram

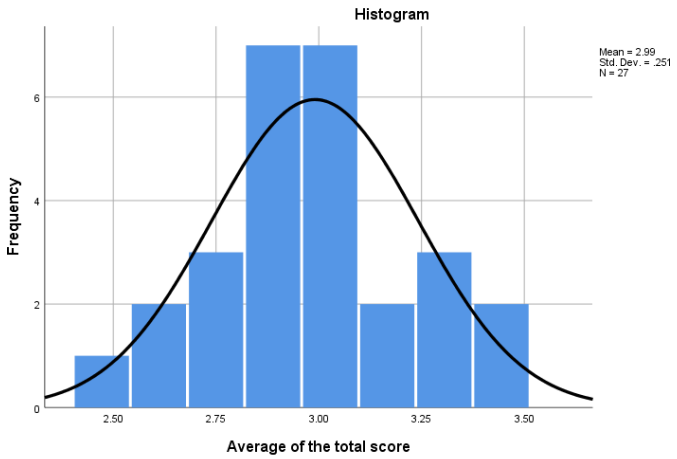

Figure 10: Normal curve of teachers' perception

The figure above (figure 10) clearly shows that most of the data are inside the normal curve which suggests that the data is normally distributed. The normal distribution of the data always gives a bell shape curve in statistics which can be seen clearly in the above chart. Hence, the data obtained from the teachers' survey tool is normally distributed.

Moreover, the researcher applied Skewness and Kurtosis to test the normality of the data which is presented in the table below (Table: 12). The researcher used the same assumptions for the Skewness and Kurtosis test of the normality as in students' responses data. From the table below (Table: 12) the standard error of Skewness is

0.448 then the range of acceptable Skewness is between -0.896 to +0.896. Since the skewness of the data is 0.088 which falls in the acceptable range. The same procedure is adopted for the calculation of the acceptably 'normal' degree of kurtosis, the researcher doubled the standard error of kurtosis which is 0.872, and found the acceptable range of -1.744 to +1.744 which contains the value of kurtosis i.e., 0.872. Hence from this observation, the researcher concluded that the collected data from the teachers' instrument is normally distributed.

Table 12

Normality test by using Skewness and Kurtosis on teachers' response.

N		Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis
Valid	Missing				
27	0	.088	.448	-.206	.872

Similarly, the researcher performs another test to conform to the normality of the data and that is the Shapiro-Wilk test for the normality. The table below (Table: 13) shows that the p-value in the Shapiro-Wilk test is 0.901 which is above 0.05 which is acceptable for the normality criteria as if the p-value were below 0.05 then it would violate the assumptions of normality of the data. In terms of the Shapiro-Wilk test, the researcher has got that his data is approximately normally distributed.

Table 13

Shapiro-Wilk test for the Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Average of	.102	27	.200*	.982	27	.901

the total score	

*. This is a lower bound of the true significance.

Lilliefors Significance Correction

Also, the normal Q-Q plot (figure: 12) shows the dots are along the line which indicates that the data are approximately normally distributed. In the teachers' data, the researcher has got normally distributed data from this figure too.

Figure 11: Normal Q-Q plot on teachers' responses

From the above assumptions and tests for the interval/ scale data and normality, the researcher found that he can use parametric tests as per the necessity and can use the non-parametric tests in the necessary condition if it is required.

One-way ANOVA on Teachers' Score

To examine the significant difference between the groups of the teachers based on their teaching experience level (in years), the researcher has used a one-way analysis of variances (one-way ANOVA) –test. The teaching experiences of the teachers are divided into three class intervals (i.e., less than 10, 10-20, and above 20). The following hypothesis was tested by using this parametric test and presented in the table below (Table: 14).

Hypothesis: There is no significant difference between the experiences of teachers on the problem in learning Geometry theorems.

Table 14

ANOVA test on the Problem in Theorem Learning based on Teachers' Experiences (in years)

	df	Mean Square	F	Sig.
Between Groups	2	.050	.775	.472
Within Groups	24	.064		
Total	26			

The table above (Table: 14) indicates that the p-value is 0.472 and the level of significant (α) is 0.05. This result of ANOVA clearly shows that the p-value > α, so we accept the null hypothesis and lead to generalized that there is no significant difference in the teachers' perception in problems in learning Geometry theorems based on their teaching experiences.

Discussion on hypothesis result of teachers' responses

The researcher has performed an ANOVA test on the teachers' responses and found that the experience of teachers (in terms of number) doesn't affect in learning geometry theorems in the secondary level.

CHAPTER V

INVESTIGATING THE REASONS OF EXISTING PROBLEMS IN LEARNING GEOMETRY THEOREM

After analysing the data obtained from the survey in Chapter IV the researcher conducted the second phase study which consists of sharing the experiences of students, teachers, and educationists and curriculum experts in Mathematics. The researcher tried to court their perceptions and experiences in "Why the students of secondary level are facing difficulty in learning geometry theorems?" to address the second research question. All the interviews in this study were collected through online mode in Google Meet. The interaction with the participants was collected in the recorded form and transcribed for the further process. The responses of key informants through in-depth interview are presented and analysed separately in the following subheadings:

From the Perspective of Students

Firstly, the researcher took the interview of two students to address the need for the second research question. The two students are selected in such a way that one is a moderate achiever and the second one is a good achiever in Mathematics. Similarly, one has just completed her Grade X and another one is in Grade X and finally, both the students are from different schools of the research site.

First Respondent: Introducing Anisha

The students are selected in such a way that one student has just completed her SEE (2020 batch) and a moderate student in Mathematics in Grade IX and X. She was a good achiever student up to the basic level in all the subjects, but she was counted in

moderate scorer in Mathematics in the secondary level. Her performance was consistent in the remaining subjects and counted among the high ranked students in the class too but her performance in Mathematics was not as satisfactory. She was a very active and energetic student in the school and won most of the events (like dance, music, debate, speech, etc.) held in school and interschool too. The researcher chooses this student in this study because despite being a good achiever in the whole class she was moderate in Mathematics and found Mathematics as her most difficult subject. She also has a lot of experience of learning Geometry theorems as she has completed both the classes (IX and X) and attempt many exams (like boost up exams, internal tests, pre-board, pre-SEE, etc.). The researcher found that her experiences in learning Geometry theorems and exam experiences on it can give an insight to my study. She is named Anisha (name changed) in this study. The discussion with this student went in the following ways:

An Interview with Anisha

Researcher: *Good morning.* (with a pleasant smile)

Anisha: *Good morning, sir.*

Researcher: *How do you do? How are your online classes running nowadays?*

Anisha: *Pretty good, sir, but not as effective as school, sir.*

Researcher: *By the way, how much GPA did you score in the SEE?* (With curiosity)

Anisha: *Well, sir, I obtained 3.85.*

Researcher: *That's great! It's a good grade.*

Anisha: *Thank you, sir.* (grining)

Researcher: *So, I think it's going to be interesting to talk with you.*

Anisha: (smiling) *I will also be enjoying a lot to talk with you sir.*

Researcher: (smiling) *Then, shall we start now?*

Anisha: (smiling) *Okay, sir, let's begin then.*

Researcher: *As you have already completed your school level education, what is your personal experience in learning Geometry theorems? Can you please share some incidents and experiences in learning Geometry theorems in your school days?*

Anisha: *It is, of course, true that I've already cleared the SEE examination. But learning Mathematics was somehow a different challenge in the learning procedure. I used to feel Mathematics as it was different from the rest of the subjects I used to have at school. Even though I was counted among the best students of the class, not only class but the whole school (based on class performance, exam score, and extra-curricular activities), I used to be afraid of failing the examination due to Mathematics. I used to secure very good marks in every subject except Mathematics. Even within Mathematics, Geometry used to seem like a demon to me. I almost used to skip every question of the Geometry theorem even without seeing them. I used to feel quite curious and create lots of curiosity towards the Geometry theorems, but I used to fear that my teacher would ask for some formula or some procedures regarding it. So, I did not use to ask any questions during the Mathematics period. Talking about the incident, once we were learning formulas for the examination and the Mathematics examination was just the day after. We all were learning together, but my Mathematics teacher called the girl who was very good at Mathematics and took with him for good guidance, I was also a good student, but he didn't pay attention to me. Being one of the highest scorers in all the other subjects, I felt, like, inferior to her and that put me under the pressure that I must do better in Mathematics to beat her and get the position back or the attention from the teacher and I have succeeded somehow only in this matter.*

Researcher: *So, you mean, you were gradually losing the attention of your teacher due to low performance in Mathematics?* (With curiosity)

Anisha: *Exactly!* (reminiscing angrily) *That was even having an impact on my whole academic study due to my unpredicted performance in Mathematics.*

Researcher: *You feel that Mathematics was a curse then?* (jokingly) *How were Geometry theorems making an impact on your Mathematics learning then?*

Anisha: *Not only Mathematics learning sir, but it was also making a great impact on my performance in other subjects too. Because it was the factor that was making Mathematics much more complicated and making the way harder to learn which led to reduce my interest in learning Geometry.*

Researcher: *In my experience as a Mathematics teacher, a learner, I found Geometry theorems are a bit difficult to learn in as compared to other sections. Although it is found false in my previous study, what is your experience in it? Why are students feeling like that?*

Anisha: *Actually, in my view, Geometry contains a lot of similar contents all together, so it makes students confused whether which is the required one in proving the theorems. When I was at the school level, I used to get confused within the different theorems in Geometry, and many times I have proved different theorems and the given statement in the question as I have memorized the steps for it. Theorems need logical solving and were a very-very difficult task for me and some of my friends too who seem to be very good in Mathematics. I used to memorize the theorems and the ways of proving them as far as possible for me without understanding them. Because of this I have jumbled the steps in the proof table and done mistakes in exams* (smiling). I was not able to score good marks from the theorem's sections in Geometry.

Researcher: *What was the actual reason why you especially used to feel Geometry as a difficult topic in Mathematics?*

Anisha: *In fact, to be frank, I never used to understand the questions clearly. I used to read the questions twice, thrice and multiple times, I even used to keep the questions pending for the last hours of the exam hoping that I could think properly about them and be able to prove them but I never could solve them by myself, sometimes I used to ask for the hints with my friends or the invigilator, but I could never solve it by myself.*

Researcher: *In my previous study, I found a high number of teachers agreeing that students feel difficult to translate word problems into figures, what is your view in this statement and why the students are feeling so? Can you share your experience in it?*

Anisha: *I think it is one of the major problems in solving the Geometry questions. Actually, what I personally feel is, the figures of the Geometry are given in such a way that no mistake is acceptable, if we get a little bit out of context, then it goes wrong and the next thing, as I have already told, questions are never given in easy words, so, of course, students would definitely feel it difficult* (laughing). *Because of the terminologies used in the sentence of the verbal problems it seems like a language \ I don't know because I feel very difficult to understand them and to translate them into figures is another level of difficulty for me. I have rarely translated the theorems (especially unseen ones) into figures because of the unclear concepts of the terminologies and confusing terms and sentences like 'chord, tangent, perpendicular bisector, medians, etc.'.*

Researcher: *From my previous study I have found that students feel difficulty proving Geometry theorems theoretically as compared to experimental verifications. Can you share your experience in it?*

Anisha: *Yes, it is true, sir, even I used to find experimental verification very easy. It's because it can be proven by the practical method and doesn't require more logical thinking. Sometimes we can use hypothetical data also while proving theorems experimentally if we have less time in examination (smiling). For example, when someone tells you or even shows you dramatically about some incident, you may forget it within a day. But when you see it practically with your eyes then you keep it in your mind for a little longer, but when you play some role in that incident then you will never forget it, the same thing happens here too, sir*. (*smiling*)

Researcher: *Oh! I see*: (*smiling*)

Researcher: *I found that students feel difficult to solve Geometry theorems without the guidance of the teacher in my earlier phase study. Can you please share your experience with it?*

Anisha: *Actually, we can't blame the level of question, but we have a problem with the teaching and learning procedures. Students are taught just to secure marks in examinations. Ignoring the tiny queries of students and focusing on the big problems, so the students know the major problems but still have problems with tiny basic things and concepts, so students feel difficult to solve the theorems without the guidance of the teacher. Our teacher focuses more on the step-by-step solving of theorems, they focus on what to do and how to do but I have found that they never focus on why to do it. In my opinion, theorems learning can be easier with the practical methods, virtual classes, and multiple ways of proving strategies with no pressure of following a single strategy to students.*

Researcher: *Why do you think Nepalese teachers are not paying attention to what students are interested in?* (laughing)

Anisha: *No, I don't mean that seriously, but I repeat that study in our school (probably others too), not only in Mathematics but in most of the subjects, are exam and grade oriented. Mathematics is quite difficult for me, so I got extra complications in it. Whenever I got any difficult questions, I start to think about the examination, this fear of difficult questions always used to choke me even doing homework and in the class too. If I need to talk about the Geometry theorems, then most of us from our class used to think 'how to cheat' rather than to learn and understand them. Many of us used to make our friends teach them the theorems during examination no matter how either giving them chocolates or the treat. I can still remember the saying of our teacher when we were near to SEE examination "theorems vanako ghokne ho ki ta bokne ho"* (Translation: you either memorize the theorems or find a way to cheat). *This scenario of our class motivates us in memorizing the theorems in our school only for exam purpose. So, it's clear that we (students) are not much worried about the knowledge but worried only about the exams.*

Researcher: *From my quantitative study I found Geometry is less matched with the interest of students. Do you support this statement? Is there any possibility of making Geometry theorems interested in learning in your view?*

Anisha: *Sir, I am a Mathematics hater student. So, I do not have any way to make Mathematics easier with any measures. But as per my experience till the 10th standard, I found that learning freely and individual dealing by the teacher as per the competency and capacity of the students could help in the change of the mindset of students and may improve the achievement in Geometry theorems learning.*

Researcher: *I have found that students have fear of the topic of Geometry theorems. Do you feel like that? What could be the possible reason behind it?*

Anisha: *Every student hasn't the same kind of mental capacity to capture each and everything said by the teacher and the textbooks. Everyone doesn't have their foot on courage zone out from their comfort zone and cannot ask questions to the teacher, and meanwhile, the teacher doesn't pay attention to low achiever, but the low achiever gets punishment by the teacher and scolded for securing low marks so, this may be the reason. And yes, I agree that I used to have a psychological fear towards, especially unseen Geometry theorems. The term 'theorems' was a fearful term for me in those days.*

Researcher: *From my earlier phase study, many teachers believe that "Because of students' less effort in learning geometry theorems, it has resulted in poor performance in learning it", do you agree with them?*

Anisha: *Yes, sir I agree with them because most of my friends used to copy the homework from the high achiever students without understanding and they (sometimes me also) used to solve and complete the given task just to show it to our teacher or I can say just to escape from the punishment. But I feel like this situation is being created by the ugly nature of theorems and our teaching-learning strategies because I am very interested to study science which is also counted as a difficult subject but I find it very easy to learn and I have achieved very good grades and have a good understanding of it but if I talk about the Geometry theorems, then I (probably others too) found it as a boring one. In my opinion, the students are giving less effort in theorems learning because they are not interested in learning like other sections and very abstract in nature.*

Researcher: *As we all know, if we leave some questions in the exam then it doesn't affect our letter grading. My question is, does this assumption motivate you to leave Geometry theorems during learning time?*

Anisha: *If I need to talk about the exam then I have never left any questions by assuming that it doesn't affect my letter grading, I have tried to give my best in each subject not only Mathematics. I used to write the given things from the question, to prove, and make the table also for the proof even though I don't know the process. But in the learning time, of course, I have kept the unseen theorem of Geometry in less priority and even our teacher used to hint us to leave that in our practice. Our teacher had categorized us in our class and he used to focus only on the high achieving students in the Geometry theorems section and only those students used to practice and solve them. In this way, majority of the students leave the theorems sections while practicing/ learning and give their focus in other easy sections just to crack the exams.*

Researcher: *Did your teacher use manipulative geometrical materials while teaching?*

Anisha: *Yes, sir! Our teacher used the wooden materials to teach the mensuration chapter, GeoGebra in transformation and Geometry. Sometimes he used to come with his laptop to teach but not in all the chapters. He used GeoGebra to teach the theorems when we were in Grade-X. But still, I can say that the materials were enough for us because we never got a chance to play and perform our activity with those materials. Our teacher used to show us from the front desk of our class.*

Researcher: *Did your teacher use to focus on group work while teaching Geometry theorems? Do you think that it is a better way for you to learn them?*

Anisha: *Yes sir!* (quite loudly) Our Math teacher used to make groups of students containing both good achievers and low achievers. He even used to keep one good achiever student in each bench and let us discuss and solve the mathematical problems at first from our level only. After that, our he used to facilitate us in our

group and individually also and used to give us only the hints to solve the problems. I found this way of learning Mathematics is much better than our previous strategies where the teacher used to solve all our difficulties on the board, and we used to copy from there. I have enjoyed this way of learning and learnt Mathematics easily in a group (from friends) but in the case of Geometry theorems, our teacher focused more only on high achieving students and let us solve other sections at the same time.

Researcher: *Do you think that the role of the internet can make theorems learning easy?*

Anisha: *Of course, the internet is making it easy to learn anything in this world. We can solve our problems and clear our concepts from the You-Tube videos and Google. I have also used the internet to learn other subjects like social studies, science but not used to learn Mathematics and Geometry theorems.*

Researcher: *Do you have a Math lab in your school? Do you think that it helps in Geometry theorems learning?*

Anisha: *No, sir! We don't have a special Math lab in our school, but our teacher used to encourage us to make some materials as our project works in Grade VIII and IX and used to keep them in the office, staff room, and some in our class only. I have also prepared some pyramids, prisms, hand-made Abacus, clocks, etc. during those days.*

Researcher: *Okay! We are almost at the end of this interview, have you experienced any other difficulty in learning Geometry theorems that I have not mentioned before?*

Anisha: *Sir…* (Taking a pause) *I think you have mentioned almost all the issues which I have experienced. Lastly, for me, the theorems should be kept in such a way in the curriculum which can grab the student's interest in them. My teacher always used to say that Mathematics is the easiest and interesting subject to learn but I never*

feel like that. He/ she always used to say that Mathematics is everywhere and each topic and concepts exist somewhere in the real life, but I never trusted him from my inner heart in this matter. I have solved so many problems from the Math book but Mathematics always seems to be a problem for me in learning. I found it as the ugliest subject on those days in learning. So, it should be designed in such a way that students can feel it easy and practicable.

Researcher: *Okay! Thank you very much for your time and your valuable experiences. I will address your experience in my study.*

Anisha: *Thank you, sir, for this opportunity. I am feeling very happy to be a part of your study.*

Researcher: *Okay then … have a great time ahead… bye*

Anisha: *Bye sir…*

(The interview ended)

Second Respondent: Introducing Liza

Similarly, the researcher took the interview of the second student who is currently studying in Grade-X and a good achiever in Mathematics and remaining subjects also. She is also found as a highly energetic, Mathematics lover and a high achiever student from the lower Grades of that school. The researcher chose this student in this study to share the difficulty faced by the high achieving students in learning Geometry theorems. She is named Liza (name changed) in this study. The interaction with this student went in the following way:

An Interview with Liza

Researcher: *Good morning, Liza.*

Liza: *Good morning, sir.*

Researcher: *How do you do?*

Liza: *I am doing well sir, thanks.*

Researcher: *How are your online classes running nowadays?*

Liza: *It's going well sir, now our school is planning for the online exams also. Probably it will be held after Dashain* (A festival in the Nepalese culture).

Researcher: *That's great, and how are you feeling learning Mathematics online?*

Liza: *It's seemed fine nowadays sir, in the beginning, I was feeling quite difficult to understand, and still it is not like the physical class, but it is understandable and fine in this pandemic situation.*

Researcher: *I have already informed and let you know about my research study. So, shall we start the interview?* (With a smile)

Liza: *Okay sir! Let's begin then.* (smiling)

Researcher: *How do you feel learning Mathematics?*

Liza: *Mathematics is my best subject in learning. I am enjoying learning it.*

Researcher: *And what about Geometry?*

Liza: *Geometry…* (Taking a pause) *It is a bit difficult to understand in the beginning but once I understand, then it becomes easy for me.*

Researcher: *Why do you think that you feel Geometry difficult to understand in the beginning?*

Liza: *Sir, I feel difficult to understand Geometry from the board teaching when our teacher teaches us. But when I solve the problem in my copy myself and clear the confusion with my teacher then I feel it easy. Normally, I can say I feel Geometry learning easy after solving any question myself.*

Researcher: *I found that students feel difficult to translate the word problems into figures. What have you felt about this? Why are you feeling like that?*

Liza: *Yes, sir. I also feel the same. Sometimes I feel difficult to understand the question and I'm not able to construct the figure. In this case, I found that I feel very easy to translate those questions and terminologies into figures which I have already attempted once but feel difficult (sometimes) in the new questions and I think this is because of the lack of basic concepts required for that particular question.*

Researcher: *From my previous study I found that students feel difficulty proving Geometry theorems theoretically as compared to experimentally. Can you share your experience with it? Why do you feel so?*

Liza: *Sir, I feel theoretical proof easy as compared to experimental verification…* (Taking a pause) *It doesn't mean that I find experimental verification difficult, they are also easy, but I prefer theoretical proof in proving Geometry theorems. It is because whatever I practice from the book and practice book, I have seen similar types of questions in exams.* (smiling)

Researcher: *And what about unseen theorem?* (smiling)

Liza: *Those are difficult, sir.* (admitting shyly) *Although I am solving most of the unseen theorems till date while practicing and in exams too, I find them more difficult than other portions of Geometry.*

Researcher: *What is your experience in learning Geometry according to the level?*

Liza: *Umm… Mathematics was easier in the earlier Grades but as the Grades increased, I started to feel Geometry a bit difficult to understand.*

Researcher: *I found that the students have psychological fear of Geometry theorems and they do not like it, what do you feel about this?* (smiling)

Liza: *I don't feel like that, they are not so difficult but in the case of unseen theorems I also feel like "I wish that questions won't come in the exam".* (giggling) *But in the case of my friends, they do not even see the theorems section. They want to pass the*

exam from the other sections only and do not want to solve the theorems. Whenever I have suggested them to prove theorems in our practice, they have directly refused me.

Researcher: *I found that you are a very laborious student but many teachers in my earlier study support that, 'because of students' less effort results are poor in Geometry'. What have you experienced in your class?*

Liza: *It's like this, sir… Students do not complete their task and do not practice also but if they get to copy from others then they copy the solutions without understanding and from the teacher's side also, they (teachers) do not check our homework regularly, they are not strict in our work because of the large number of students, they check only those copies which we submit. In this sense, I found there is less effort from both teachers' and students' sides in our learning.*

Researcher: (smiling). *As we all know, if we leave some questions in the exam then it doesn't affect our letter grading. My question is, does this assumption encourage you to leave Geometry theorems during learning time?*

Liza: *No, sir, I can't leave any questions by assuming that it doesn't affect my letter grading.* (With a smile and taking a pause). *If I don't know any theorems then I write the given information, to prove section, table, and some steps of proof for some marks but I never leave any theorems in the exam. In fact, I love marks.* (grinning)

Researcher: *Do you feel anything like that while learning Geometry theorems?*

Liza: *No, sir. I never felt like that while learning also and I have not left any theorems because of letter grading.*

Researcher: *Does your teacher use manipulative geometrical materials while teaching Geometry theorems to clear your concepts?*

Liza: *No, sir. I have never seen any materials used by my teachers in my class.*

Researcher: *What about ICT (like laptops, computers, tablets, etc.)?*

Liza: *No, sir, I have never experienced anything like that also in my school.*

Researcher: *Do your teacher focuses on group work while teaching Geometry theorems? Do you think that it is a better way for you to learn Geometry theorems?*

Liza: *Yes, sir. Our teacher used to make a group of 3/3 (one high achiever and two low achievers) students and let us discuss and practice. I think this is a better way of learning theorems because our low achieving friends are also scoring comparatively good marks than before but sometimes, I feel disturbed and irritated while teaching them as they don't know even a simple concept also but I enjoy the group works with a similar type of students.* (smiling)

Researcher: *Do you think that the role of the internet can make theorems learning easy?*

Liza: *Yes, sir. Sometimes I have used Google to search and understand some questions, terminologies, and concepts of Mathematics but I am less familiar with the use of the internet in theorem learning.*

Researcher: Do you have a Math lab at your school?

Liza: Yes, sir, we have.

Researcher: *Have you ever been to the Math lab to use the materials or do your teacher use them in your class?*

Liza: *No, sir, I have never experienced anything like that.*

Researcher: *Have you experienced any other problems in learning Geometry theorems that I have not mentioned above?*

Liza: *In the beginning of theorems learning in Grade-IX, I used to see them as a very big challenging section. I used to understand nothing on those days but later I learnt individually with one of the teachers at our school and then afterward I started to find them easy but still I have a little fear of unseen theorems in examinations. I prefer*

individual learning with my teacher in Geometry theorems as I understand very little from the whiteboard.

Researcher: *Have you ever memorized a theorem?*

Liza: *No, sir. I have never memorized a theorem.*

Researcher: *What do you want to improve in the teaching-learning strategies in learning Geometry theorems?*

Liza: *I think it would be best for me if our teacher gives more time to teach this theorem section. Our teacher teaches ¾ theorems in a single period by saying that we have a very limited time. I wish they taught a few theorems in a single class and treated us individually as far as possible in this situation.*

Researcher: *Okay! Now we are at the end of this meeting. Thank you for your valuable time and for sharing your experience. I wish you a bright future.*

Liza: *Thank you, sir!*

(The interview ended)

From the Perspective of Teachers

Similarly, the researcher took the interview of two Mathematics teachers (1 male and 1 female) to serve the need of the qualitative study i.e., the second research question. Both the teachers are selected from two different schools who have spent more than two decades teaching Mathematics at the secondary level. The researcher took the interview through an online approach in Google to meet with recording mode and later transcribed it in this study. The female teacher is named Shreya and the male teacher is named Ghimire while transcribing the interview where both the names are dummy names. The discussion with these two teachers went in the following way:

Third respondent: Introducing Shreya

The female participant teacher in this study is working as a permanent Mathematics teacher and a principal in one of the reputed community schools. I found her to be a great woman who has spent more than 30 years of her life uplifting the educational practices in Nepal and assurance of quality education in community schools. Her contribution to school Mathematics as a teacher and an educator is admirable. In this scenario, the researcher found her as a huge source of information which can contribute a lot to this study.

(In the previously planned schedule, the researcher calls the participants and sends the link for the interview. The interview is recorded in the Google Meet meeting.)

An interview with the female Math teacher (Shreya)

Researcher: *Ma'am, Namaste!*

Shreya: *Namaste, sir!*

Researcher: *How are you, Ma'am?*

Shreya: *I am very fine sir, and you?*

Researcher: *I am fine too ma'am, and how are your days going on?*

Shreya: *Nothing special, sir! Nowadays, we are busy with online classes and I need to go to school every day to manage the administrative work.*

Researcher: *(Taking a pause) And ma'am, how are you feeling about conducting online classes of Mathematics for secondary level.*

Shreya: Umm… *Nowadays I am not conducting any online classes for my school… We have two other Mathematics teachers in our school who are conducting online classes for our secondary students and it is going in a good manner. Around 75% of the students are connected in this new approach of teaching and learning and still,*

25% of our students are not connected with us in online studies. But we are satisfied with our work through this method and we are still trying to give our best in it.

Researcher: *Ma'am, as I have informed you in the phone call and emailed too that, I am conducting this interview for my research study (thesis), so I want to record this meeting with your permission.*

Shreya: *Sure, sir, you can (She replied with a pleasant smile)*

(The researcher turns on the recording mode and starts a formal talk for the study)

Researcher: *Ma'am, can you please share your brief experiences in learning Geometry theorems during your school days?*

Shreya: *Okay… thank you, sir, for the question… (Taking a short pause) As you are asking about my experiences in learning the Geometry theorem, I want to describe it in short…*

Mathematics was my favourite subject from my school days only but in the case of Geometry theorems, it was quite tough than other sections of Mathematics on those days for me. There used to be only theoretical proof in those days, and we used to memorize them according to their numbers like Theorem 1, Theorem 2, Theorem 3, etc. We used to prove the theorems without any understanding of it.

(Taking a short pause, she added) *Nowadays, it is quite easy to understand the theorems because of experimental verifications which were not there in the Mathematics curriculum during our school days.*

Researcher: *In my quantitative study I found a high number of teachers agreeing that students feel difficult to translate the word problems into figures, what is your view in this statement and why the students are feeling so? Can you share some experience?*

Shreya: *Obviously, sir, it is true that a majority of the students feel difficult to translate the words of sentences into geometrical figures, this is because of less*

familiarity of students with the Mathematical terminologies and vocabularies. In my experience, it can be easy if we (teachers) are able to give conceptual understanding with the Mathematical terminologies like basic properties of geometrical shapes, the relation between lines and angles, chord, arc, etc. from their primary and basic level.

Additionally, she replied that *"If I need to divide my students into 3 groups according to their mathematics achievement then only the high scores group can solve the theorems easily, the moderate group can solve if the theorem is easy and the low achiever group rarely solve it and I found even the high achiever group feel difficult to translate the words into figures in theorems."*

Researcher: *From my quantitative study I found that students feel difficult to prove Geometry theorems theoretically as compared to experimental verification. Why? Can you share your observations and experiences in it?*

Shreya: *Yes, sir… I also agree that students feel easy in proving theorems experimentally than theoretically. It is because the steps are similar in most of the cases and a higher number of students used hypothetical data in it. But my experiences show that a higher number of students admit mistakes in experimental verification while using hypothetical data. For example: If any student needs to show that "The sum of opposite angles of a cyclic quadrilateral is supplementary", they show the sum is 180^o but the measure of the acute angle and obtuse angle don't match with the figures drawn in their copy which can be easily detected by the teacher and there can be a high chance of losing the marks.*

Researcher: *What is the role of the foundation of basic level Mathematics in learning Geometry theorem? Can you share some experiences?*

Shreya: *Yes sir, the role of foundation of basic level, even primary level is very crucial in learning Geometry theorems as the focus in the basic concepts like angles,*

line, geometrical figures are more in these levels. In our case, I found that many of the teachers in my circle omit this chapter in the lower level by assuming that Geometry is a tough chapter for the students and do not give the proper concepts of it and because of this we (as a secondary Mathematics teacher) are facing problems in the basic concepts and terminologies of Geometry in secondary level students. I have found many of the students do not know how to write the angle and can't recognize them when figures are given.

Researcher: *From my quantitative study I found 'Geometry theorems are less match with the interest of students', why the students feel like that? Is there any possibility of making Geometry theorems interesting in learning?*

Shreya: *Yes, that is true, but all the students do not feel like that. If I need to take an example of my so-called talented students, they want to prove Geometry theorems first whenever I give any model question to them. I have seen many times that they look at the unseen theorem first and judge the difficulty level of the question paper whenever they see any new question paper. I agree that most of the students do not like to solve the theorems but those who are interested in it and able to solve/ prove it can feel all the other sections of Geometry and even Mathematics easy for them. I also found the theorems are like an addiction in a few students who always want to prove new and new theorems.*

Researcher: *A majority of teachers in the quantitative study agreed to 'Because of students' less effort in learning Geometry theorems, it has resulted in poor performance in learning it', are you agree with them? Why do they feel so? Do you have any lived experiences on it?*

Shreya: *Thank you for the question, sir. I like this question but in my experience, we can blame neither the students only nor the teachers only. In my opinion, learning is*

teamwork between teacher and students. In this sense, I found teachers, students, and even parents are equally responsible for the achievement of any student in theGeometry theorem.

Taking a pause…

If a teacher left any student thinking that he/ she can't solve the theorems, then the student alone cannot do anything. So firstly, we need to motivate our students in learning Geometry theorems then we need to teach them from simple to complex forms. A teacher also needs to labour more in this section than other areas of Mathematics in students learning. Secondly, the theorems are not only tough for the students, but I found many teachers in my teaching career who feel Geometry theorems are difficult for them to teach. In this scenario, a teacher needs to pre-plan his/ her class according to the level/ capacity of the students while teaching Geometry theorems. A teacher needs to be well prepared before entering a class and need to design a proper activity for the students according to their level and capacity.

She added… *Although I have taught Geometry theorems for more than 30 years for the secondary level students, I still plan before entering my class which is required for all the teachers in my experience to improve Geometry theorem learning.*

Researcher: *As we all know if we leave some questions in the exam then it doesn't affect our letter grading. My question is, does this psychological assumption motivate them to leave the Geometry theorems section during learning time only? Why it is so? Are they leaving this section because of its toughness?*

Shreya: *Yes, I agree with you… The letter grading system openly lets students do better in a particular subject, not in all general. If you are poor in Math, lower grading doesn't affect you if you are studying a non-technical subject. So, students believe in such a way that low grade in Math doesn't affect them. But in the case of*

the best-achieving students, they feel that they may lose some marks from other sections too in the examination because it is not 100% sure that all the questions except Geometry theorems can be correct so, they pay equal attention towards the theorems in my context. In this scenario, as a Math teacher in my school, I always tried to counsel and motivate my students in learning Geometry. I inspire them by saying that Geometry theorems can broaden your thinking power, reasoning skills and develop a logical mind as Geometry theorems need a lot of logic in their proving. In my opinion, as a Math teacher, we all need to motivate the students in learning any area so they can feel it easy and encouraged in the learning process.

Researcher: *From my previous study and my experiences too, I have found that the teachers are not satisfied with the students' performance in geometry in terms of their conceptual understanding and achievement in assessments. What could be the possible reasons behind it in your view?*

Shreya: *Yes, I agree with you… Not only in the upper standard but also the basic level and primary classes, teachers had expressed their dissatisfaction on teaching Geometry to conceptualize to students. A majority of the teachers try to put the victim box on students or the context, but the reality is they hide their weakness. As a teacher, we never see the situation from the learners' view and always blame the students for their low achievement and less competency in Mathematics. This scenario results in poor achievement in Mathematics in our country.*

Also, if you really work on from the primary level over the subject (Math), try to make it more practical based, exposure to the environment to Math related, through games and other… but I doubt either teachers lack technical or subjective skills or do they just merely teach as a job, which makes the differences.

Also, we have such a lack of co-ordination in our school system that creates the blaming game. The secondary teachers blame the basic level teachers and basic level teachers blame the primary level teacher for not giving the clear concepts in Geometry/ Mathematics and the primary level teachers believe that students slowly develop the concepts through the age and on a grade (class) basis. This is also playing a part in poor performance in Geometry.

Researcher: *In my first phase study majority of the students agreed that their teachers do not focus on group work in proving Geometry theorems. Do you think that this can be the reason behind the low achievement of students in Geometry theorems? Why this factor is responsible for difficulty in learning Geometry theorems? Can you please share your experiences in it?*

Shreya: *Yes, it really affects in learning. In my opinion, it creates a better learning environment if we make a heterogeneous group of students where all kinds of achieving students can interact with each other than individual learning strategy. In my experience, if we focused on individual work inside the classroom while teaching Geometry then students feel monotonous and they seem lazy which we can easily observe as a teacher. All the students in any class may not feel comfortable interacting with the teacher, in this situation also pair learning, and group learning can help them to shut out their difficulty in learning Geometry theorems or any area of learning. Some students hesitate to ask simple concepts with the teacher in front of the class but can easily share with their friends and also a good achiever can make a better understanding in Mathematics and last for a long duration in their memory while teaching to his/ her friends.*

Researcher: *High number of teachers in my previous study have agreed that they have not got sufficient and effective training to teach Geometry theorems. What is*

your opinion on this statement? Why we are less able to get/ provide such training to the teachers? Why our training for overall mathematics is less able to address the Geometry theorem section?

Shreya: *Yes, sir…*

In our context, we always keep Geometry as the last option. In the case of training, I have not experienced the chapter-specific training, but it can be of overall Mathematics where we touch Geometry. In the case of Geometry theorems, we need some specific training and sharing sessions where we can learn and know the different strategies of different teachers in theorem learning. Like we can learn about new/ new strategies and use of technology in Mathematics from young teachers and they can also learn the pedagogical approaches from the old teachers (teachers who have worked for a long time).

Researcher: *In what ways you see the role of the internet in learning Geometry theorems? Why do students need the internet to clarify their ideas in learning Geometry theorems? Can you please share some examples?*

Shreya: *It may be very useful in learning Geometry theorems but as a teacher, I have used it less in teaching Geometry. I found a high number of teachers are using YouTube, Google, and many other online tools by using the internet in this pandemic to teach mathematics but I have not used it as I am running the administrative section this year.*

Researcher: *'The role of a Math lab is also found as a reasonable factor in learning Geometry theorems' as very few students have agreed that they have a Math lab in their schools to learn Geometry in my first phase study. Can you please elaborate on its role and share how it is responsible for learning Geometry theorems with examples?*

Shreya: *Yes sir…*

Nowadays, Math lab is being very essential at the school level to give conceptual understanding to students and I have also started to work in it in my school. How far I know about it, I believe that most of the materials in the Math lab should be prepared by the students themselves by using local materials in which they can experiment their ideas and play with them to create a logical understanding. Some materials we can buy or get from the external sources also that should be kept separately according to the learning areas like Algebra, Geometry, Arithmetic, etc.

Researcher: *Finally, we are at the end of this interview ma'am… can please summarize your ideas in problems in learning Geometry theorems and possible strategies to overcome it based on your experiences and observations?*

Shreya: *You have discussed most of the problems sir… but still I have found that, up to the end of the secondary level many students are not able to write the name of angles, their measurement and even don't know that they need to write the capital letters in the vertex of geometrical figures. Still, it is a very big challenge to teach and give conceptual understanding to our students in Geometry and especially theorems.*

Similarly, we need to have a separate department of Mathematics where all the Mathematics teachers at that school can share their ideas in teaching Mathematics and its concepts. It is necessary to give concepts of Geometry from the primary to basic level to achieve good performance of students at the secondary level. For this, the higher-grade teachers can provide the necessary training and feedback for the lower-grade teachers and need to work together in uplifting Geometry and Geometrical thoughts in students from the primary level.

Researcher: *Okay ma'am now I want to end this meeting… thank you for your valuable time and your experience… It was a great moment with you.*

(She also asks me about the interview whether I have got my desired data or not and I replied to her that I will contact her again if I get any confusion or any queries in her response)

Shreya: *Okay, sir… then I am also getting late for my school, see you next time…*

Researcher: *See you, Ma'am!*

(The interview ended.)

Fourth Respondent: Introducing Ghimire

Similarly, the second respondent teacher in this study is a male teacher from another reputed community school. He is also working for 27 years in teaching Mathematics to the school students and a permanent teacher of the Nepal Government from 2071 B.S. He is using different types of strategies like project-based learning, use of ICT in Mathematics classroom, and advocates for the applied Mathematics in the school curriculum. The researcher found that his experiences and innovative ideas in teaching Geometry theorems can give an insight into this study.

An interview with a male Math teacher (Ghimire)

The interview starts informally in the beginning and the formal talk starts after a short conversation.

Researcher: *Namaskar, Sir.*

Ghimire: *Namaskar, Sandip ji.*

Researcher: *How was your day?*

Ghimire: *Well, I had a busy day.*

Researcher: *Are you tired? Are you comfortable with the interview?*

Ghimire: *No, I am not tired. I attended a few online meetings. As usual, I took some online classes. I mean to say, I am comfortable with the interview despite the tight schedule.*

Researcher: *Sir, I need to record this interview for transcribing. May I record it?*

Ghimire: *Sure. I know the importance of recording for a researcher. You also need it as evidence.*

(After getting the permission, the researcher starts recording)

Researcher: *I think, I should begin it with your school days. How did you read geometry theorems? What were the challenges and obstacles? Will you please, describe your experiences and feelings?*

Ghimire: *Well, talking about my school days, my school was located in a hilly region, where there were a few numbers of schools. We could hardly meet the mathematics teacher for six months in a year. The school used to hire mathematics teachers from the city. The teachers used to teach just for two-three months and leave. Then the school had to search for another new mathematics teacher. At that time, I had no idea about its cause. Later on, I knew that the teachers used to come to our school after giving I. Sc. exam. They used to teach in our school until the publication of their result. After the result, they used to leave the school for their higher study. That means we hardly got a chance to read mathematics for a whole year. We had to depend on the self-study. At that time, I had no idea that mathematics could be learned by doing practice. For other subjects, I used to revise a few days before the examination, but in mathematics, I used to go to take the exam without practising. I took the mathematics exam based on classroom reading only. Taking about geometry theorems, instead of answering the theorem by its statement, we used to answer by the theorem number. That means we used to memorize the theorem number and its whole answer without understanding the statement of the theorem. For example, in the exam, if anybody said, its theorem number 22, then all of us used to write the same answer for the theorem. Sometimes our answer would be wrong. I completed my study*

up to class ten in that way. In school, I had read mathematics in Nepali medium, but in I. Sc. I had to read in English medium. For the first 3 to 4 months, language became the barrier for me. I got into doldrums, whether to change the faculty or continue science. Later on, some of my friends including me decided to continue science. Our background was similar. We started to read mathematics by group discussion. Then I knew that mathematics should be practised in understanding its basic components and logic behind it.

Researcher: *That means, you passed school level mathematics by rote learning. Didn't you, Sir?* [Researcher asked seeking confirmation]

Ghimire: *That's right. You got it. (Ghimire nodded his head with acceptance). In our time, we had to read geometric theorems in optional mathematics as well. The theorems of optional mathematics such as Ptolemy's theorem, theorems on properties of triangles were very tough and challenging. The proof of some of the theorems used to be of a length of one and a half page or even two pages. I also memorized those tough theorems by rote learning. I never understood all those in my school life.*

Researcher: *Sir, it is said that even students who are good at mathematics and teachers, both feel geometric theorem section difficult. What is your experience about it?*

Ghimire: *As a student and as a teacher, I have slightly different experiences. When I was a student, I did not know the connection between the succeeding theorems with preceding theorems. That means as a student I never knew that initial theorems could be implemented in proving the succeeding theorems. As a teacher, I have found three categories of students. First excellent, second medium, and third is low level. Excellent students are the students having high logical power. They like to interact and learn by the innovative methods. I have found excellent students showing interest*

in Geometry and doing geometrical portions easily. I have also found many excellent students who can solve the unseen geometry theorems before the teacher can solve them. On the other hand, medium students and low-level students do not want to open geometry. They cannot solve even basic and very simple problems.

Researcher: *Is geometry really difficult for most of the students?* (Researcher puts his opinion acknowledging the opinion of respondent)

Ghimire: *Yes, most of them feel geometry difficult.*

(Respondent agrees and adds)

Excellent students in a class are not more than 10 or 15%. They give interest in geometry and the remaining 85% of the students still take geometry as a difficult portion.

Researcher: *What could be the possible reasons behind it, Sir? Could you please explain through some light based on your experience?*

Ghimire: *In my understanding, the curriculum and teaching trend in Nepal fails to connect mathematics with daily life. Students learn a theory in the textbook and the theory is implemented nowhere. For example, let's leave geometry and take an example of the area of four walls. We, teachers, give the length, breadth, and height of a room and tell students to find the area of four walls of a room. Neither we teachers taught our students to find the area of four walls of their room by measuring the length, breadth and height nor did the curriculum tell us to do. So, in my opinion, the content of the curriculum is not connected with the practical, which is the main cause behind it. For example, if my students ask me, "Sir, where this mathematics is used?" To answer them I say that mathematics is read for two reasons. First, to solve the problems of daily life whereas the second, as a base of higher-level mathematics. I simply answer that the mathematics that you read is used in your house, in your*

society, and you can think mathematically everywhere. The previous curriculums fail to show the direct link and use of mathematics with day-to-day activities but the new integrated curriculum which is going to be made has brought a few concepts of mathematics which are linked with daily life. I am hopeful that the curriculum will gradually change.

Researcher: *In my quantitative study I found a high number of teachers agreed that students feel difficult to translate the word problems into figures, what is your view in this statement and why do the students feel so? Can you please share some experiences?*

Ghimire: *I agree with that. There are two types of word problems where students feel difficulty. Students feel difficulty in converting word problems of algebra in symbolic form and word problems of trigonometry and geometry in pictorial form because their mathematical language is very weak. Their mathematical vocabulary is less. In my experience, they are weak in geometry from the primary level due to two reasons. First, in the primary and lower secondary level, the geometry portion used to be kept at the last of the textbook. Second, mathematics teachers of primary and lower secondary level teachers do not teach geometry portion with enough activities and interaction. When the geometry portion is kept at the last of the textbook, there is a high possibility of leaving the geometry portion by teachers due to the lack of time. I have also found that teachers of primary and lower secondary levels not giving importance to it. I had also raised a voice about it in the discussion for the curriculum development process. Experts have realized it and kept the geometry portion at the beginning of the textbook, which we can see by the analysis of textbooks especially from grade one to grade five. In my experience, I have found many mathematics teachers at the junior level do not give enough time for the geometry portion. For*

example, geometric shapes have been kept from grade one. In the staff meeting when I asked how they taught the geometric shapes then the mathematics teacher teaching in the junior section replied, "Sir, I completed this lesson in one day. It seemed very simple. I just have to make my students able to recognize basic shapes such as rectangle, square, triangle, cylinder, sphere and it was very easy." I checked the curriculum and found the allocated time for that lesson was 15 to 16 periods. It is clear that when the teachers complete such topics in a few teaching hours, they are not using enough activities in geometry teaching. So, in my opinion, if the students are weak in geometry from the primary level, that is reflected in the secondary level. Let's take another example, if we ask any student of the secondary level to draw a triangle of sides 4cm, 5cm and 10 cm, then the student will try to make the triangle for about two hours. This is because the student has not learned practically. If the student has learned the theory and practice simultaneously, then it would have been easy for him/her to say that since the sum of two sides of the triangle is less than the third side, the triangle cannot be constructed. That means students are very weak in basic concepts also.

Researcher: *From my quantitative study I found that students feel difficult to prove Geometry theorems theoretically as compared to experimental verification. Why? Can you share your observations and experiences in it?*

Ghimire: *Obviously. In experimental verification, students have been involved in the measurement process along with the teacher. So, they feel easy but in the theoretical proof, they have to memorize and use the previous theorems and the concepts learned in the same class and previous classes. Due to the lack of enough practice and less involvement in the interaction, their logical power has not been developed and they cannot solve the theoretical proof. I have also experienced that students can draw the*

figure if the statement of the theorem is given such as "perpendicular drawn from the centre of the circle bisect the chord", where students can keep naming according to their wish. But if, the question asks, "draw perpendicular OM from the centre O to the chord AB and prove that OM bisect AB", then the students cannot draw the figure. Theoretical proofs of statements are difficult for students. Moreover, unseen theorems are very difficult for them. Only ten percent of the students can solve the unseen problems if the unseen problems have been already practised by them. They cannot solve the unseen problems if they have not practised the theorem before and have to immediately create the new solution procedure with new ideas.

Researcher: *What is the role of the foundation of basic level Mathematics in learning the Geometry theorem? How can you say so? Can you share some experiences?*

Ghimire: *I have already told you that the foundation of basic level mathematics is very important in geometry learning. If students have mastered the basic level concepts then the higher-level mathematics will be easier otherwise, it will be very difficult for them. In our society, if any student fails in mathematics at the junior level, we upgrade him/her saying that it is just mathematics. We keep on upgrading and the student reaches from grade one to grade ten even s/he is weak in mathematics.*

Researcher: *It is said that students have psychological fear towards geometric theorem. What is your observation on it?*

Ghimire: *Not only in geometry, but students also have psychological fear for the whole mathematics. The first cause of psychological fear towards mathematics in our society and the second cause is the teaching-learning practices. Our society has understood and portrayed mathematics as a difficult subject. Parents including senior sisters and brothers do not believe that their child/brother/sister can do better in mathematics. In mathematics, everything comes in sequential order. Without*

mastering the concept of one level, students cannot learn the content matter of higher-level properly. For example, when students are learning the theorems on the relation of area of triangle and parallelogram on the same base and between same parallel lines, they need to memorize the properties of parallel lines, the concept of corresponding angles from grade eight. Properties of angles formed on parallel lines are not taught in grade ten. When students cannot memorize such small properties from the lower level, psychological fear attacks them.

Researcher: *In my previous study, about eight percent of the teachers had said that present students are less laborious as compared to the previous students. This is one of the causes of difficulty in geometry learning. What does your experience say about it?*

Ghimire: *I don't like to blame the students only. I think, we teachers are also equally responsible for it. Of course, these days students are involved in other extra activities which have reduced their interest in learning. At the same time, are we teachers been able to apply the alternative approach for geometric learning? Have we searched for any new engaging and interesting methods? Are we clear on our road map? Therefore, I believe both the teachers and the students are equally responsible for it.*

Researcher: *You mean the teachers have not been able to modify themselves according to the changing time. Do you want to say that?*

Ghimire: *Absolutely, you got the point.*

Researcher: *It is said that one of the causes of geometry difficulty is less use of concrete and local material in geometry teaching. What is your understanding of it?*

Ghimire: *I agree with this statement. I think teaching mathematics without material is meaningless. I have seen some of the mathematics teachers blaming their school for not allocating enough budget for mathematics teaching materials. They blame their*

school for not buying the demanded materials. But I think as a mathematics teacher, it is sufficient to design a plan for making local materials. In my case, I just design projects for material making with clear instruction. I assign these projects to the students during the summer and winter vacation. I also allow them to demonstrate their project works in the class. I can use the materials designed by my students from grade one to grade ten. For example, in grade one, I can use these materials to show the shapes of geometrical shape. At the lower secondary level, I can use them to teach to calculate the surface area. I can easily teach various exercises of mensuration using these materials. I have found materials prepared by the students are better than the materials made by myself. Moreover, I have experienced the involvement of students in material design is beneficial for gaining conceptual understanding. Being a community school teacher, I do believe that teaching mathematics with such materials, is not so difficult for standard schools also. I recommend the proper use of such concrete materials, either readymade or local for meaningful mathematics teaching.

Researcher: *In community schools, teachers' training is frequently conducted in comparison to intuitional schools. It has been argued by many mathematics teachers that even if the mathematics training is being conducted, there are fewer specific training for geometric teaching but for teaching geometric theorems of 9 and 10, there is no training. What do you say about it?*

Ghimire: *Sir, allow me to share some bitter facts about the training.*

Researcher: *Sir, Please.*

Ghimire: *NCED used to conduct 10 months of competency-based teachers' training for the teachers of non-educational background. In the later phase, most of the teachers are from an educational background. Nowadays, demand base training and*

refresher training are being conducted. Competency-based training has been phased out. I also worked as a top trainer for competency-based training in touch with NCED. I had seen trainees taking training only for allowance and time-pass. This was the bitter truth. In those 10 months of training, there used to be a proportionate amount of training for arithmetic, algebra, and geometry. But, when trainees come only for allowance and time-pass, how could they acquire competency? Talking about the demand base training, on the first day of the training, the demands from the trainees are collected. And based on need and demand, a week's training package is designed. When the demand is for geometry teaching, the package is designed for the same. However, trainees should not forget that there is no capsule-like training for geometric teaching. Teachers should themselves search for ideas and methodology for geometric teaching. In my opinion, teachers should leave searching for ready-made geometry teaching training. Now, we are in the pandemic of COVID-19. Feeling the necessity of online teaching, those teachers who had never used computers are also learning computer skills themselves. Likewise, if teachers feel the necessity of Geometry teaching package, I suggest instead of searching for a ready-made package, they should design themselves. It is the responsibility of teachers as well. These days it is easy too. Four or five teachers can meet online and exchange their ideas. When ideas of five teachers are exchanged, it is far better than ready-made training.

Researcher: *I have experienced that these days even good students are leaving the geometry theorems due to the grading system. They argue that securing 90 and 100 both means grade A+ and even by leaving geometric theorems if grade A+ is scored in the exam, then why give importance to the difficult theorem? Many teachers also have shared a similar experience. What is your understanding of it?*

Ghimire: *Regarding it, I have a different experience. It is the mentality of medium level and low-level students only. Even high performer students cannot guarantee that by leaving the geometry theorem they can secure 95 out of 95. They always are afraid of dropping their score below 90 if they encounter some challenging questions. Therefore, they do not want to leave the Geometry theorem. I have not found any of my high performer students suffering from that mentality. Instead, I have found them giving more than one month before appearing the SEE to attempt the questions of group "D".*

Researcher: *Some of my students have told me that the geometric theorems are rather difficult and time-consuming. They have also said that they can prepare other questions themselves on time.*

Ghimire: *That sounds good. That's your experience……!*

Researcher: *In the first phase of my study, many of the students (participants) have agreed that their teachers promote individual learning instead of group learning in geometry learning. They have felt their teachers focusing less on group work and more on a traditional approach. What do you think? Which method is better in geometry learning?*

Ghimire: *Individual learning can never be as effective as group learning in any subject. However, parents and some of the teachers have miscomprehensions about group learning. If a child has combined study with his/her friends, parents think that their child is wasting time in a bad circle. When a good student is helping his/her weak friend in learning, even teachers tell him/her not to spend time and concentrate onfrom self-improvement. Parents and teachers are promoting individualism. Individual learning could be helpful for securing marks but form group learning students can learn many more skills. We, teachers, have two responsibilities on our*

shoulders. First, complete the course on time. Second, make the students efficient. To make students efficient, teachers have to involve students in group work and project works but in the content courses. That's why teachers are compelled to follow the traditional approach and unwillingly promoting individual learning. I accept that we teachers have not been able to involve students in a sufficient amount of group work, but I feel that group work is far better than individual work.

Researcher*: Definitely, from group work, many skills can be learned, knowledge can be shared. My experience shows that I have learned and understood many more things by teaching than by individual learning.*

Ghimire: *Yes, you're right. In group work when students teach each other, they can exchange their ideas so that they can increase their confidence level and they feel that they can do better in the next time.*

Researcher: *For example, if inside the classroom some students are introverted and hesitate to ask the teachers can also feel comfortable to learn from friends through group work.*

Ghimire: Absolutely.

Researcher: *That means group learning seems useful in theorem learning, doesn't it sir?*

Ghimire: *Yes, it is much helpful.*

Researcher: *The pandemic of COVID -19 has taught us the importance of the internet in online teaching. What do you think Sir? Does the internet play a significant role in theorem learning?*

Ghimire: *Yes, it does. In a classroom, due to the time factor, we can teach limited things whereas students can explore unlimited things through the internet. If we teach certain properties of a triangle and tell students to search more about it on the*

internet as project work, then students will search for it can bring more information. They get the chance to learn the same things in various ways. They can read articles. They can watch short videos tutorials. They can know its history and application. Before the Pandemic of COVID-19, I used to seize the mobiles of students. Now, the circumstance has been changed. I am encouraging my students to use good smartphones and laptops in learning. Students enjoy learning through the internet. Due to the age factor, there is a chance of misusing of the internet, but the parents and the teachers should take care of them. The internet can be a useful means of learning.

Researcher: *The same problem or statement can be seen from multiple perspectives, can't it Sir?* (Researcher seeks acceptance from Dahal)

Ghimire: *That's correct.*

Researcher: *While we are talking about technology, what do you think about the role of ICT?*

Ghimire: *In mathematics learning?*

Researcher: *In geometry theorem learning.*

Ghimire: *In geometry learning, as we have already discussed, students have difficulty in converting statements into figures. With the help of ICT, we can display the figure making process in a sequential order which is helpful in giving the stepwise conceptual knowledge. I am convinced that ICT makes learning easy and is helpful in geometry learning. I also feel that learning should be ICT friendly.*

Researcher: *For Example, if we use GeoGebra, we can teach the theorems of circles in an animated way. We can show the sum of the opposite angle of a cyclic quadrilateral is always 180o whatever may be the size of the circle or quadrilateral.* (Researcher gives specific examples of ICT)

Ghimire: *You're right. Similarly, we can use GeoGebra to teach transformation such as reflection, rotation, translation, and enlargement. With a single click ,we can rotate the geometrical figures to certain degrees. Students are habituated with plotting the figures in the graph only. When they see the animated and colourful pictures, they will remain in their memory for a longer time. In geometry also, students can learn concepts of theorems by self-practicing with the help of GeoGebra which makes the concept permanent.*

Researcher: *Such concepts are printed in their mind and become permanent, aren't they, Sir?*

Ghimire: *Yes, yes...!*

Researcher: *We are almost to the end. In the end, will you please tell me what types of other difficulties have you experienced in theorem learning?*

Ghimire: *Not all learners keep theorem learning in priority. Forward learners are using theorem learning to make their mind creative, which has shown more development in their other parts. Talking about difficulties in teaching-learning, I have found mixed types of students. Some students feel geometry difficult whereas others feel algebra difficult. It depends upon the environment and the perception of the students. All the students do not have the same type of mindset. There is a trend of taking mathematics as a difficult subject among students. To remove the difficulties in learning geometry, I feel the new curriculum should contain Geometry theorems, which has a practical use. Such theorems make geometry teaching more effective. If the new curriculum contains such theorems, then the students and teachers of the new generation will not have to face the difficulties faced by us.*

Researcher: *So, you feel if theorems are taught by connecting them with real-life activities, then the interest of the students towards theorem will increase and learning will be effective, don't you Sir?*

Ghimire: *Yes, Mathematics in the application. The concept of two mathematics has emerged.*

Researcher: *Applied mathematics!* (Researcher speaks with curiosity)

Ghimire: *If we go in an applied way, students will acquire a permanent image of the concepts, which students will have to use directly in their daily life. It will increase the effectiveness of learning. It will also convert the detest of people towards mathematics in the positive direction and tomorrow we may see the day when people may feel mathematics is one of the easiest subjects to read and score marks. Young teachers like you have a long time to teach. I hope you will see such days in the future. Although I have left around ten years to teach, I am optimistic that I too will see those days.*

Researcher: *That means if we connect mathematic with real life, there is the possibility of seeing such days.*

Ghimire: *Yes, there is a possibility. The latest curriculum of mathematics has given little space for the practical application linking mathematics with real life. It is a positive step. In developed countries, mathematics and its application have been included in the curriculum. As our country is also enlisted under the developing country, I hope the new curriculum, will be formed after five to ten years and will meet the standards of the international mathematics curriculum. Uh…I have to take about the efficiency of teachers as well. In the past, after completing the education of one level and not being able to do anything, people used to join teaching. The teachers of that generation are about to leave. When the old generation leaves, the*

coming new generation teachers will not obey the old concepts. I hope after the phase over of the old curriculum and teachers of the old generation, mathematics will be converted into applied form and it will become one of the easiest subjects.

Researcher: *The present mathematics, which we have been using, is: "We are solving the problems of mathematics, mathematics is not solving our problems."*

Ghimire: *I agree with you. These days we are solving the problems of mathematics and mathematics is not solving problems because neither our teaching nor our learning is of that level.*

Researcher: *Okay sir! Now we are at the end of this interview. I want to thank you very much for your time and wonderful experience. I may contact you again if I need to ask anything more about my issue with you. For now, I want to end this meeting.*

Ghimire: *Sure sir! You can contact me again if you need me. I am feeling very happy to be a part of your study. And thank you also for giving me this opportunity. Now, you can end the meeting, good night!*

Researcher: *Good night, sir!*

(The interview ended)

Introducing Fifth Respondent: An Educationist (Dr. Math)

Similarly, the researcher took the interview of an educationist in Nepalese Mathematics to see the problems in learning Geometry theorems through the educationist eye, who is an Associate Professor in the Department of Mathematics Education at Tribhuvan University, Nepal. He has earned his Ph.D. in Education (Mathematics Education) from Tribhuvan University and his research interest ranges learning strategies, teaching styles and strategies, teaching approaches, assessment of students achievement, integration of ICT in teaching and learning Mathematics, and other cross-cutting issues regarding education. His research in school Mathematics

education has a huge contribution to change our conventional chalk and talk teaching method. He has served more than 20 years of his academic currier as a Mathematics teacher in different schools, colleges and also worked as a teacher educator under Nepal Government for a long time. The researcher found that he can be a huge source of data for this study as a teacher, as a teacher educator, and expert in this field. His experience in his research studies on school students and teachers is also another plus point for me to select him as my research participant. The participant is named Dr. Math (name changed) in this section. The discussion went in the following ways:

An interview with Dr. Math

Researcher: *Namaste, sir…*

Dr. Math: *Namaste…*

Researcher: *How are you doing?*

Dr. Math: *I am doing well, thanks, and you?*

(The researcher shows the topic and purpose of the research in screen sharing and makes the respondent aware of the study)

Researcher: *Sir, may we move towards the official conversation?*

Dr. Math: *Ok sir, let's start.*

(The researcher starts the recording after taking permission from the respondent and begins the interview)

Researcher: What is your personal opinion on learning Geometry theorems? Can you please share some incidents or experiences in learning Geometry theorems in your school days? Why do you feel so?

Dr. Math: *Umm… (With a little smile) talking about my school life, I was comparatively good at mathematics than others as I used to pass the exams with good marks. On those days I needed to do most of the household works because I was the*

eldest child in my family which caused me to miss the first period almost every day in school. I can remember that we used to have our mathematics period between second and tiffin break at the secondary level, so I had never missed it. We used to get a lot of homework, but I didn't use to get enough time to solve it because of excessive works at home and I used to complete them by scanning the patterns of the problem and whenever my teacher used to ask me why I wasn't completing the work (assigned homework), then I used to answer with full confidence that I could solve them on the board and I have done that too.

Although mathematics was easy for me some sections like algebra equations, verbal problems of arithmetic. and as you have talked about Geometry, so verbal problems of Geometry (theorems) were quite difficult for me at the beginning of the secondary level. I have felt trouble proving Geometry theorems because I used to feel difficult to find the connection between the statements and the reason used to prove the theorems but the latter was because of being unclear about it and when I started to make a clear concept with the help of my teachers and friends then again, I started to find it much easier than before. I even used to prove the theorems on the board with chalk in the break time too when I started to have an interest in it. Comparatively, I used to feel experimental verification easier than the theoretical proof and up to the end of the secondary level of that time, Geometry was the easiest chapter in Mathematics for me and also, I had attempted all the question correctly in the S.L.C examination from Geometry but I had left some questions from other section like arithmetic.

Researcher: *In my experience as a teacher and a learner and also from my quantitative study, I found Geometry theorems are a bit difficult to learn in*

Mathematics as compared to other sections; what is your view on this? Why are the students feeling like that? Can you suggest some examples?

Dr. Math: *Yes, you are right. If we look at the overall students, then they feel Geometry theorems difficult. I have also taught for school Mathematics for a long time and my experience shows that students do not have clear concepts of axioms, postulates, and basic concepts of Geometry like angles, lines, etc. Because of this situation, students do not know where and how to apply those logics which play an important role in proving Geometry theorems in secondary Mathematics. Similarly, the process of modifying the figures through construction to make them provable is a great challenge in ordinary students in Geometry theorems like sometimes we need to construct a line to make two triangles and then showing them congruent or similar. I found the students are failing to find the connections between the given information and 'to prove' in Geometry theorems. They feel difficult to find the logic and concepts in which the theorems are based like they can't identify whether they need to apply congruency or similarity or any other ideas or concepts while proving Geometry theorems.*

In my opinion, the teachers are also very responsible in this as they prove the theorems on the board directly without giving a chance for students to think and labour in it. I also found that a teacher does not give the answer of 'why' after using any logic, like why are we applying this logic only, can't we apply any next, is there any possibility of proving that particular theorem from any next method, etc. We do not let students search the reason behind each logic and concept used in proving Geometry theorems which leads to poor understanding and creates a problem in its learning. We are focusing only on procedural learning rather than conceptual.

Researcher: *What is the role of the foundation of basic level Mathematics in learning the Geometry theorem? How can you say so? Can you share some experiences?*

Dr. Math: *Yes, that is obvious as our curriculum has a sequence from one grade to another. Obviously, we need proper foundational knowledge of Mathematics to solve/ prove Geometry theorems in secondary schools. For this, it is necessary to give a conceptual understanding of the concepts of Geometry which requires the connection of the Mathematical concepts to the real world. If we are able to connect the concepts with the context then it might be supported in learning Geometry in upper grades. As a teacher, we need to let students think and analyse the concept to relate to their context rather than to memorize the concepts.*

If a student is not able to find the connection of the problems to their real-life and fail to understand it then they can't put their interest in learning it which leads to arise a problem in learning Geometry theorems. Our teaching-learning strategies should be improvised in such a way that can create enough space for students to understand the concepts and let them create their logic in proving Geometry theorems.

Researcher: *From my quantitative study I found 'Geometry theorems are less match with the interest of students', why the students feel like that? Is there any possibility of making Geometry theorems interesting in learning?*

Dr. Math: *Yes, that is true. The most important factor in learning is the motivation of the learner, without it, it is very difficult to involve any learner in learning activities and expect the desired outcomes. Firstly, our culture of the practice is also responsible for it as our teachers, parents, school administration, students circle, establish that 'Math is difficult', 'only a bright student can study mathematics', 'Math is only for the boys', etc. in the learner's conception. Such myth in our society, school,*

and even in the classroom creates fear and anxiety in students towards Mathematics/ Geometry and there is very little chance for learning in a fearsome environment. A student does not start any theorems of Geometry by thinking that he/ she can't solve it. They fail to solve it just because their teacher had implanted the statement 'you can't solve the theorems' in their mind. How is learning possible in such an environment? So, firstly we all need to change our mindset towards Geometry to get a better achievement in it.

Just before few days, I had presented a lesson plan of one of the schools of Japan where a teacher needs to teach "Area of a triangle is half of the area of a parallelogram standing on the same base and between the same parallels". The teacher is not speaking there in the beginning, the teacher first shows a video related to the issue and gives a real-life situation of land and lets them find the solution from there. It was seen that students had brought so many solutions for the given situation and reached a conclusion. This way of teaching and learning can build a conceptual understanding of the learners which is also necessary for our schools. We also need to follow such strategies rather than feed our students' minds with our prepared recipes of the logics and concepts. We need to change ourselves from a teacher to a facilitator and a mentor who can create a good learning environment for the learner. We can apply the ZPD (Zone of Proximal Development) approach of Vigtosky in learning Geometry theorems.

Researcher: *In my quantitative study I found a high number of teachers agreed that students feel difficult to translate the word problems into figures, what is your view in this statement and why are the students feeling so? Can you share some experience?*

Dr. Math: *Yes, it is true. There are several stages of understanding like teaching for understanding, teaching for assimilation, teaching for permanence, teaching for*

transfer. The main issue is the level of understanding in this case. If a student is not able to understand 'what is given in the question' and 'what that question is asking for' then he/ she won't be able to draw the figure from that question, so to overcome this issue we need to let them try for several times, let them discuss in their groups and finally let them reach the correct figure and its solution themselves. But in our case, it is different, a teacher draws the figure of most of the questions, only a teacher proves most of the theorems , and a teacher only wants to impose his/ her ideas and method to students. We are not focusing on students' reasoning, analysing, an interaction which can create rational thinking and logical empowerment. In my opinion, proving theorems is a way of giving logic and reasoning to a certain statement and idea to conclude. We need to provide enough learning environment to our students which seem to lack in our teaching and learning strategies. Students feel difficult to convert the languages in Mathematical forms which requires reasoning capacity in students. The proof depends on reasoning and for reasoning, we need to focus on the intuition of the students.

Researcher: *The majority of teachers in the quantitative study agreed in 'Because of students' less effort in learning Geometry theorems results in poor performance in learning it', are you agree with them? Why do they feel so? Do you have any lived experiences in it?*

Dr. Math: *I do not want to agree on blaming students for their low achievement. If any teacher is saying like that then there might be the lacking point in his/ her teaching strategies. Students are coming to school to learn something so; it is our duty to create a proper learning environment and motivate students in learning anything. Students do not labour hard because we are not providing them with a better learning environment, we are failed to impose the conditions and questions*

according to their interest. We are failed to connect our concepts to the student's contexts. If we start to teach a theorem without telling it as a theorem and the abstract things like… "Your father has a land of a parallelogram shape and your uncle have another land in triangular shape now please find how you can make their area equal…" Teacher need to let students for the discussion… In this way, a teacher needs to contextualize any issue of the theorems and need to impose the questions in students' interest which can motivate and attract students in the learning area, and we can get the better achievement.

When I was in school days a few of us (students) used to discuss and put the arguments in group work in break time which make us different (good achiever) from our other friends. So, it is also necessary to focus on group work and teachers need to find the learning problems in groups and individuals both and need to treat them according to their need and level. Teachers need to impose the problems according to their level and interest like if any student is interested in playing games then a teacher needs to be able enough to connect his/ her game to the mathematical concepts. I also used to say that "students are not achieving good because of their less hard work" in my earlier days of teaching but later I found that the real problem was my thinking, my teaching strategy, and within me but not my students. We need a transformation in our teaching-learning strategies. A teacher needs to transform from a teacher to a facilitator. In my opinion, "we are solving the problems of Mathematics, but Mathematics is not solving our problems" so, we need to teach in such a way that our problems of Mathematics need to pinch students' real-life situations. We can also take the example of the Math war of America and the Mathematics teaching strategies of Russia in our context.

Researcher: *As we all know if we leave some questions in the exam then it doesn't affect our letter grading. My question is, does this psychological assumption motivate them to leave the Geometry theorems section during learning time? Why it is so? Are they leaving this section because of its toughness?*

Dr. Math: *Some teachers might have agreed with this statement, but I am not agreed with this. In my opinion, most of the students want to attempt and solve the maximum number of questions in the examination. If they are leaving any question or Geometry theorems, then they might have left because they might not be able to solve it but a student does not leave any question just because of 90 and 99 in the examination. Some students might feel like that and for that also a teacher is responsible because a teacher is not able to motivate and create a better learning environment for such students and make them aware that you can leave it in the exam, you cannot solve it and this is not of your level, and so on. In Mathematics unseen theorems are challenging problems, they are in the production level of problems but not a routine problem. To solve a non-routine problem a student needs to have conceptual understanding and those students leave such theorems in the exam who do not have enough conceptual understanding to solve that problem.*

It is also not sure that the student has correctly solved all the other questions and leaving the theorems will not degrade their marking. So in my opinion, students do not leave the theorems by thinking that they can score A^+ without proving it. A teacher's motivation is required to overcome this issue.

Researcher: *From my previous study and my experiences too, I have found that manipulative geometrical materials are less used in our secondary schools so that the concept of the students is not clear, and they are less motivated in learning it. Why the*

situation is like this? Is there any way to overcome such practices in your view? Can you please share some experiences?

Dr. Math: *Yes, I agree with you. A teacher can relate most of the problems of Mathematics to the students' life. He/ she can create a mathematical problem in the students' real context. Our curriculum and textbooks also fail to address such issues properly because our teachers and students are not familiar with this approach of teaching and learning practices. In the name of concrete materials, we are using only the Geometry box in teaching-learning Geometry. Despite it, there is minimum use of concrete and locally prepared materials in Geometry teaching and learning. Apart from concrete materials, we can use virtual software like GeoGebra and many more to clear the geometrical concepts which are also less addressed in our schools. We can easily show the connections between the concepts and solve almost all the theorems of Geometry at the secondary level by using ICT tools. In this scenario, our teachers use the concrete materials and ICT tools less in teaching Geometry in our schools which leads to difficulty in learning Geometry theorems.*

Researcher: *High number of teachers in my previous study have agreed that they have not got sufficient and effective training to teach Geometry theorems. What is your opinion on this statement? Why we are unable to get/ provide such training to the teachers? Why our training for overall mathematics is less able to address the Geometry theorem section?*

Dr. Math: *If we take the reference of our Nepalese educational agencies then they claimed that all most all teachers are well trained in Nepal. Yes, it is true that in counting the numbers maximum teachers at community schools are well trained but the question is, what type of training they have got, how the trainers are giving the training and how much knowledge the teachers are utilizing in their class*

performance, that is import in my view. And the next important thing is to monitor and investigate whether the teachers are utilizing the training or not. Also, the,main part of the concern is whether the teacher trainer is familiar with the modern practices of teaching (like ICT, contextualization) or not. Because of this pandemic, many of our Math teachers became familiar with the ICT tools used in Math classrooms but before this, I can say that very few teachers were only using ICT in their Math classes. Still, I have found that the young teachers have more competency in ICT knowledge than the aged ones and applied that knowledge in their practices, but our senior (in terms of working ages) teachers are still very less familiar with those tools. The trainer of our context was also less familiar with the use of such tools (ICT), they have taught the use of paper folding and some concrete materials, but they were also not enough in my view which I have also realized personally as I have also worked for a long time as a teacher educator under Nepal government.

I was also unaware of the ICT tools and contextualization of Mathematics and its concepts on those days. Use of certain materials like tangram, the abacus was also rare as the majority of the teachers kept those materials in the storeroom of the school and never utilized the training in their classroom activity. In this scenario, there must be changes and modification in our teacher's training teaching-learning strategies, curriculum, textbooks which can address the norms and condition of modern and student centred approach which can solve the real-life problem of the learner and which can be techno-friendly.

Researcher: *In my first phase study a high number of students agreed that their teacher does not focus on group work in proving Geometry theorems. Do you think that this can be the reason behind the low achievement of students in Geometry*

theorems? Why this factor is responsible for the difficulty in learning Geometry theorems? Can you please share your experiences in it?

Dr. Math: *If we take the example of national curriculum 2076 then it mentioned individual work, group work, project work, activity-based learning, etc. in school Mathematics. Additionally, the use of ICT, contextualization, interdisciplinary connections is also mentioned there. But our teachers are unaware of it. They even don't know about the curriculum; we are just focusing on textbook teaching and learning. We conducted a survey a few months back in some districts of the far-western development region of Nepal with the teachers, where I had asked the curriculum-related questions with the teachers there and found that they are totally unaware of it. It is mentioned to conduct group works and project works in the chapter of Mathematics but our teacher does not follow that. There is another problem in our sitting arrangement of the classroom also which is not the best fit for group works.*

The classroom environment is the most important factor in learning which also seems not favourable in many of the cases. In our survey I found that more than 100 students are in the same class (single room) and each bench contains 6/7 students, they are not feeling comfortable even writing in their copies and their textbooks are overlapped on the desks. In this scenario, how a teacher can conduct group work and manage the materials for group work and project works. There are not any materials in school so, it is also a very big challenge to conduct group works in such situations for a teacher.

Now, our government needs to change the policy in education in which size of classrooms should be spacious and several students in a single classroom must be fixed which can be handled by a teacher through multiple perspectives. If we take the

example of the developed countries in teaching Geometry, we can see the vast difference between our and their educational practices. Our classroom, the number of students, sitting arrangement, and even teaching-learning activities, all need to be modified to get the desired outcomes from it.

Similarly, the problem in the textbooks is not designed in the way which requires group works, teachers do not want to labour to create such works and activity, by looking the condition of the school also it is not favourable for such works so, we are failed to conduct group learning, pair learning which is very important in learning Geometry and even Mathematics. Vygotsky also prefers group learning which can make students able to think from multiple perspectives through interaction and collaboration which leads to critical thinking, so we need a drastic change in our educational policy to make Geometry easy to learn. Hence, there is a great role of group work in learning Geometry theorems.

Researcher: *"The role of Math lab is also found as a reasonable factor in learning Geometry theorems' as very few students are agreed that they have Math lab in their schools to learn Geometry in my first phase study. Can you please elaborate on its role and share how it is responsible for learning Geometry theorems with examples?*

Dr. Math: *Obviously, we all need a Math lab in each school because unless we have enough materials with us, we will not be able to use them as per our needs. But whenever I visited some schools in Kathmandu valley, they have a Math lab in a cupboard with very few materials. They even don't have enough basic materials which can be used to give basic concepts in Geometry and overall Mathematics. A school needs to have enough teaching-learning materials according to the number of students and concepts where students can perform experiments, can use in their study, and play with them to create something new in their concepts and ideas. A student can*

create a better understanding of the experiment with concrete materials, as Mathematics is also a part of science, it requires experiments to learn its concepts. If we take reference of Bruner theory, the Van-Hiele Model of Geometry thinking that advocates the visualization of geometrical concepts and it can only be possible through concrete materials and real context.

Researcher: *In what ways you see the role of the internet in learning Geometry theorems? Why do students need the internet to clarify their ideas in learning Geometry theorems? Can you please share some examples?*

Dr. Math: *Internet is a mean which gives access to connect a student to the world through the virtual platform. Students can use YouTube, Google, online software, and many other sites to upgrade their knowledge, ideas, and concepts in learning Geometry. Nowadays Google is being a great teacher for anybody to learn anything. The current generation of students spend more time using gadgets (mobile phones, laptops, etc.) and spends their huge time on the internet. In this situation, if we are able to motivate in using Mathematical puzzles, Mathematical games, and also if we are able to design any other platform where students can learn with fun then it can also contribute a lot in theorem learning. Teachers and students both can get access to multiple learning strategies and ways of proving theorems which helps them to choose an option according to their need and competency level. For this also a teacher can motivate his/ her students to use their gadgets without misusing them.*

Researcher: *Finally, we are at the end of this interview so, please summarize your ideas in problems in learning Geometry theorems and possible strategies to overcome it based on your experiences and observations?*

Dr. Math: *In my opinion, to make Geometry theorems easy in learning we need to focus more on contextualization of the mathematical concepts, visualization of the*

concepts, linkage between the different topics in Mathematics (like algebra, arithmetic) to Geometry. The learning strategies could be like… At first, the teacher needs to pose the problems to the students and let them think and analyse individually for some time, then they should be allowed to discuss their ideas in a group or a pair, then they need to present in the class (with all the groups) and finally, a teacher needs to conclude and facilitate their ideas and creativity in the given problem which may create a better learning environment. The teacher needs to facilitate each student individually and in a group too. The sitting arrangement of our classes should be arranged in such a way where students feel comfortable to create and share their ideas.

There are many methods of proof like inductive proof, deductive proof, method of contradiction, etc. A student should be free to use any method at first to prove the theorem that enhances their creativity. A teacher needs to be aware of the learning theories like Bruner theory, Vigtosky theory, Van-Hiele, Ausubel, Gagne and need to follow their strategies according to our context and also need to follow the knowledge gained from the training inside the classroom. The most important part of learning is students so, they need to be motivated and get a rich learning environment and a teacher needs to be like a facilitator and a mentor. Additionally, to prove Geometry theorems a student needs to be aware and able to find the linkage with the associated with axioms, definitions, previously stated theorems, and possibly related concepts individually or within a group and need to focus on rational thinking and reasoning capacity to prove Geometry theorems. Also, a student needs to be aware of procedural fluency and conceptual understanding to prove Geometry theorems.

Researcher: *Thank you sir for being a part of my study and giving your precious time***.**

Dr. Math: *Thank you also for choosing me as a part of your study. I hope you will make a good research study… okay… Good night!*

Researcher: *Good night sir!*

(The interview ended)

From the Perspective of Curriculum Expert

Finally, the researcher interacts with the curriculum officer in school Mathematics from CDC (Curriculum Development Centre), Nepal to find the possible reason behind the difficulty in learning Geometry theorems. The researcher believes that the curriculum of Mathematics can be responsible for the difficulty in any area of Mathematics for school students. The researcher also tried to seek for the lacking point in the Mathematics curriculum which may create problems in learning Geometry theorems. The officer is named as Mr. Expert in this study.

Last Participant: Introducing Mr. Expert

The researcher took the interview with a curriculum officer in school Mathematics who has worked firstly as a secondary Mathematics teacher in different schools in Kathmandu valley and currently working as a curriculum officer in the curriculum development centre of school education. I, as a researcher, believe that his experiences both as a teacher and a curriculum designer can help me to investigate the weakness and obstacles in designing the context-friendly and learner-friendly curriculum. I have also investigated the designing policy of the content area and activity in Geometry theorems. The interaction with the officer went in the following ways:

An Interview with Mr. Expert

Researcher: *Good evening, sir!* (with a pleasant smile)

Mr. Expert: *Good evening sir, how can I help you?*

Researcher: *Respected sir, I am conducting my research on topic teaching and learning on Geometric theorems, so I want some help trough your sides, could we start?*

Mr. Expert: *It's ok, I will try my best to support to complete your task.*

Researcher: *Could you provide your information about your current professional engagement?*

Mr. Expert: *Ok, I started my professional journey as a mathematics teacher at the school level. I have spent around 10 years teaching mathematics and science at the school level. After that I was able to succeed to become a government officer in the Education sector then currently, I was working as a Curriculum expert and officer at Curriculum Development Centre (CDC) under the Ministry of Education of the Government of Nepal since 7 years.*

Researcher: *Could you remember your experiences of learning Geometric theorems in your school education?*

Mr. Expert: *Of course, during my school education there was not any fixed pattern of learning geometric theorems. We used to memorize and try to symbolize the side, vertices, axioms, etc. during learning theorems. After symbolizing we used to compare the contexts where we should make equal sides, angles, or other contents for memorizing them. I have no complete sense of knowledge of theorems like right now. Cleary, I used to memorize all the theorems.*

Researcher: *There is a thought that geometric theorems are difficult than other content, how did you fill at that time?*

Mr. Expert: *In my experience, Geometry is quite difficult than others but those seen theorems were easy due to routine practice and solving but those out questions from seen theorems were difficult as I could not connect the right axioms and path of*

solving them. I used to solve the out theorems if I had seen them before otherwise, I didn't solve them.

Researcher: *Could you justify your experiences that Students can not translate the word problems into figures?*

Mr. Expert: *Yes, it is the main problem from the past experiences to the recent trends of teaching and learning of geometry. We used to visualize the word problem of maximum practised content but could not be able for new content. In the recent trend of maximum schools, only a few number of learners who got good marks/grades can convert the word problem of geometry into figures, but maximum learners couldn't translate.*

Researcher: *As a curriculum expert makes the curriculum, could you address this problem to make it easier or to give alternative ways to solve this kind of problem?*

Mr. Expert: *As curriculum experts, we have thought to address the problem in various ways. The old curriculum is designed in a theoretical approach where actually we are not applying the mathematical learning through three stages (concrete, pictorial, and abstract). Recently most of the teachers are teaching to give concept, examples, and verbal problems but in the new curriculum, we are trying to design bar model method from the lower class and starting the content from the real-world problems of learners as an inductive method which may solve the problem and the learner could visualize the content. We hope the new could address the problem by providing an alternative approach connecting the problem to context.*

Researcher: *Could the curriculum address such problems to connect the content to real-world problems or why our curriculum couldn't address such problems?*

Mr. Expert: *Curriculum is always general, but those issues should be addressed in the textbook and teachers' guide. But in our context curriculum is designed in one*

way by an expert group where the interest and concern of learners would be addressed less. On the other hand, textbook writers and teachers' guide designers would represent the content matter in a different tract. The curriculum designer should have thought to collaborate to address the problem. The coming new curriculum would address the issues in the right track. Curriculum only makes the track to connect in the real world, but it should include in the textbook and teachers guide.

Researcher: *To some extent, the current curriculum also focuses on alternative ways such as project-based learning, activity-based learning but the teachers are not addressing them, how do you feel about such issues?*

Mr. Expert: *Obviously, the recent curriculum has included the modern approaches of learning to some extent, but its implication is quite different. I agree that the curriculum designer would think in one perspective rather than implementation complications. Actually, the interest and issues of learners are more important than the thoughts of the designer. On the other hand, our teachers are not changing from traditional to modern approaches, they are not adopting the recent trends and skills for better achievements and learnings. The policies of the government are also to enhance the strength of teachers in the community schools as only the trained teachers can enter the teaching profession. Some of the teachers are also using the modern approaches but the main concern is curriculum design and implementation should match in the right track. I think one other main problem is the attitude of concerned human resources where our trend of supervision and monitoring are not very strong/effective.*

Researcher: *What is your opinion on students finding experimental verification easier than theoretical proof?*

Mr. Expert: *There was no experimental verification section at my school level in that curriculum. Based on my teaching experiences, learners find it quite easier in an experimental method where they can engage themselves for solving the problem but due to the lack of concept and connecting skills, learners feel difficulty in theoretical proof.*

Researcher: *Students fear theorems. Why are we not able to make them interesting to the learners?*

Mr. Expert: *Yes, actually we are not able to make theorems according to the interest of the learners. The main cause of this issue is we could not to connect the geometric problems to the real-world of the learners and on the other hand, the curriculum is generic for all, but our classroom is multicultural (on the issues of cast, language, ethics, traditions, etc.) So they are producing a psychological pressure on the learners making them fear Geometry. There is also the problem of classroom pedagogy and attitude in mathematics teaching.*

Researcher: *Do you think that the use of teaching and learning materials for the conceptual understanding of geometry is sufficient in the current scenario?*

Mr. Expert: I found, s*ome of the teachers are using the teaching and learning materials but in general, maximum teachers are not using them in their classrooms and follow the traditional lecture method. The curriculum and other facilitating documents are organized on one aspect, but the implementation is different. Due to such a gap, it is creating a dilemma, so the achievement in geometry is less than others. Another main problem is the learning schooling of teachers that they want to teach in the same way they learnt.*

Researcher: *As a curriculum expert you are a responsible person for the implementation of the curriculum then how do you found that teaching geometric theorem is one of the difficulties for the teacher as well?*

Mr. Expert: *In my experiences of classroom observation as a responsible person of Educational Training Centre (E.T.C.), I have found major two issues of teaching geometry. One is, there are some conceptual problems in teachers and their content knowledge. On the other hand, most of the teachers feel quite difficult to teach geometry that the conceptual teaching and connecting geometric content to the real-world problem are more difficult in comparison to other content.*

Researcher: *How do group learning, collaborative learning, and peer learning affect the learning of geometric theorems in learners?*

Mr. Expert: *Group learning, collaborative learning and peer learning make more discussion among the learners which enhances the concept of the learners. Learners may hesitate with the teacher so they can't express their feeling but on group and peer discussion the slow learner could discuss freely with a fast learner. Obviously, similar to other content group learning, collaborative learning and peer learning increases the conceptual understanding of learners.*

Researcher: *How does our curriculum focus on peer learning?*

Mr. Expert: *Curriculum is always simple and generic but these issues (Group learning, collaborative learning, and peer learning) should be addressed by textbooks, teacher's guide, and activities on classroom pedagogy. In our context, the aspects of the curriculum and its major themes addressed by classroom activities are very less. The implementation of innovations and modern approaches are the direct concern with teachers and the attitude of teachers plays a major role in it. The recent textbook of CDC has included these issues to some extent.*

Researcher: *As a curriculum expert how do you suggest minimizing the problems of teaching and learning Geometry?*

Mr. Expert: *There should be various corrections in our practices from all stakeholders. The curriculum designer, implementation body (Schools, administration, teachers, and learners), and supervision body all have to interact and collaborate for better achievement. The curriculum designer and implementation are the major concern who have to address the concern and interests of learners. The right collaboration among all stakeholders may produce a measurable change in a short duration.*

The interview ended.

Analysing the Interview

The data from the interview have been firstly sorted, coded then categorized, and reviewed for relevance. Thematic analysis is adopted for the interpretation and analysis procedure in this phase of the study. The researcher interviewed the participants in this study on three separate occasions. Firstly, the researcher phoned the participants and connected with them on social sites and, made them clear about the purpose and objectives of the study. Secondly, the researcher used Google Meet for the interview procedure and recorded it for further use with the permission of the respondents. Thirdly, the researcher called some participants also through the phone in some unclear data provided by them during the transcribing procedure and noted in a diary. Then the researcher started the analysis procedure after transcribing the interview data in written form. Yin (2003) argued that “data analysis consists of examining, categorizing, tabulating, or otherwise recombining the evidence to address the initial propositions of a study” (p.109). Similarly, Rubin and Rubin (2005, p.202) write that data analysis is a process “to discover variation, portray shades of meaning

and examine complexity" which moves from the raw interviewed data to evidence-based interpretations. The coded raw information is put together to generate the themes which are interpreted with the necessary supportive literature. According to Rubin and Rubin (2005), "using published literature to suggest concepts and themes by which code is legitimate as it will help you relate your findings to what others have already written" (p. 209). Based on the collected data from the second phase study, the researcher had formed six major themes for analysis procedure. The analysis and interpretation go in the following ways under the themes:

Impact of Teacher-Student Relation in Theorems Learning

"Learning is a process that involves cognitive and social psychological dimensions, and both processes should be considered if academic achievement is to be maximized" (Hallinan, 2008, p.271). It is found that to get a better achievement in learning, the relation between the teacher and the learner must be parallel and harmonic. In the interaction with the students, Anisha argued that "*I almost used to skip every question of geometry theorem even without seeing them*" and she also added that "*I used to fear that my teacher would ask some formula or some procedure regarding it*" while asking any questions which show the weak coordination between a teacher and a student in learning geometry theorems. Ghimire and Dr. Math have also complained about the teachers' nature towards the students in Mathematics classrooms. In this scenario, the researcher found that a majority of the students do not feel comfortable asking and raise their questions in a Mathematics classroom. Most of the respondents of this study also support that the pathogenic nature of Mathematics teachers is creating the problem in it. The educationist (Dr. Math) argued that nowadays it (fear with Math teachers) is quite minimized in our schools as

compared to a few years back but still the influence that Math teachers are strict and the fear with the Math and Science teachers in our school students is the same. Many researchers like Birch and Ladd (1998), Hamre and Pianta (2002), Eccles and Wigfield (2002) have advocated that the strong relationship between teachers and students is essential components to the healthy academic development of all subjects in school education in their research study.

In our context, the researcher has found that the trust between the teachers and students has some gaps as the teachers believe that it is necessary to keep distance with students in Mathematics learning and need to be strict otherwise students won't follow the instructions of the teacher. And on the other hand, students do not feel comfortable sharing their difficulty in any area of Mathematics with the teachers. The participant students of this study also argued that they feel uncomfortable because some of them do not know the basic concepts also and they feel humiliated in front of the teacher and their friends to ask questions. Only the good achieving and selected students can raise their questions in their difficulty. They also argued that they have faced very few Math teachers who are friendly with all the students in the class. They also replied that other subject teachers (except Math and Science) are more friendly with students and students can easily clear their misunderstanding with them because "talking with a teacher and conducting observations in the classroom will provide important and unique information for designing interventions" (Hamre & Pianta, 2006, p. 55).

It is also found that there is a credible indication that the nature and quality of teacher's relations with students have a noteworthy outcome on their learning (Howes et al., 2008; Pianta et al., 2009; Guo et al., 2010). The participants like Shreya, Ghimire, and Dr. Math in this study also support that the relation between a teacher

and students must be familiar where each student of the class can share his/ her difficulty and misunderstanding without any hesitation with his/ her teacher. As they all also accept Geometry theorems is one of the difficult portions in Mathematics to learn which can be simplified only with enough interaction and sharing of concepts and conflicts between teachers and students. They all believe that a strong teacher-student relationship may be one of the most important factors in modifying a student's educational path (Baker, 2006) which can support Geometry theorems learning. And they also assert that the concepts and terminologies required for the Geometry theorems learning can last for a long time in a student's memory as "lasting change does not result from plans, blueprints, and events, rather change occurs through interactions of participants" (Mohrman et al., 2003, p. 321) and also added that "through studying student-teacher interaction, our conceptualization of what constitutes motivation to learn increasingly has involved emotions as essential to learning and teaching" (Meyer & Turner, 2002, p. 107). Similarly, Hamre and Pianta (2006) also argued that a strong teacher-student relationship can "provide a unique entry point for the educators working to improve the social and learning environments of schools and classrooms" (p. 49).

Creswell (2009) argued that "meanings are constructed by human beings as they engage with the world they are interpreting" (p. 8). This constructivist view in learning Geometry theorems was supported by Ghimire and Dr. Math in the interview where they claim that the connections of the content to the context or sharing any issues of Geometry theorems in between teacher-student is only possible in a healthy relationship between teacher and student. The teacher and educators in this study were also focusing that the teen-agers can be easily diverted from the study due to the teacher's behaviour so a teacher needs to act like a facilitator who can guide and

coach a student in learning Geometry theorems. As Darling-Hammond (2006) explains that, “teaching is in the service of students, which creates the expectation that teachers will be able to come to understand how students learn and what students need if they are to learn effectively – and that they will incorporate that into their teaching” (p. 4). Enough interaction between a teacher and a student is required to solve the misconceptions and clear the concepts. There can be a lot of confusion and misconceptions in Geometry theorems for students which can be solved and clarified only by a joint contribution of a teacher and a student in learning theorems. In this scenario, Marzano (2003) writes “the core of the effective-student relationship is a healthy balance between dominance and cooperation” (p. 49). The participants like Shreya, Ghimire, and Dr. Math in this study argued that a teacher needs to be more responsible to establish a healthy relationship between a teacher and a student. They all support that a teacher should provide a good learning environment to all the students in learning Geometry theorems. Theorems learning should be made interesting for the learners in order to motivate and attract them towards it by a teacher. Researchers like Crosnoe et al. (2004); Hamre et al. (2012) also examine the value of a teacher’s affective insight when it comes to a teacher’s effectiveness as an educator. Downey (2008) also writes that “teachers need to know how their daily work in classrooms can be infused with interactions and instructional strategies that research has shown can make a positive difference in the lives of students who are at risk of academic failure” (p. 56). The above scenario shows that a teacher needs to act as a facilitator in order to establish a healthy relationship with the students which can create a better learning environment and contribute to Geometry theorems learning.

Teaching Learning Strategies in Geometry Theorems

As I discussed in the previous chapter, teaching-learning strategies impact directly in theorems learning. As a teacher and a researcher, I have put this issue in the frontline in my research study. I have collected the issues from my quantitative study and verified them with a teacher, student, educationist, and a curriculum expert to investigate the reason behind it. While going through the literature the researcher found that "very few studies have focused on the teaching of proof in the context of teachers' day-to-day instructional practice" (Stylianou et al., 2009, pp. 5-6). The researcher tried to cope-up with the literature with the respondents' experiences in teaching and learning strategies and style in this section.

In the interactions with the respondents in this study, the researcher found that the teachers are most responsible for creating difficulty in theorems learning from a teacher, student (Shreya and Ghimire), and educationist (Dr. Math) views. All three of them were arguing that the teacher needs to create an environment where a learner can be motivated to learn anything. When I asked them "Because the less effort in learning Geometry theorems results in poor performance in learning it" do you agree with this statement? All three of them did not want to accept it totally. All three of them were blaming out teaching-learning styles and strategies which is guided by conventional approach and argued that "when students are taught with method dissonant from their learning style and strategy preference, they do not succeed in mastering the subject matter as quickly as they could" (Doolan & Honigsfeld, 2000, As cited in Khanal, 2018, p. 4). In this scenario, one of the respondents, a teacher, of this study, Ghimire argued that we are not even clearly focusing on lecture method also while solving or proving any theorems in Geometry we are focusing only on the steps and explaining the answer of 'what' and 'how' only but very few teachers only focused on the answer of 'why' i.e. why we are doing that particular step, why do we

need that step only, etc. “Our focus is less with the reason behind each step and terminologies while proving Geometry theorems”, he had argued in a quite loud voice in the interview.

The researcher also found that all the respondents were not satisfied with our current practice of teaching and learning Geometry in our context. Effective learning strategies for students can significantly contribute to expanding students’ achievement (Protheroe & Clarke, 2008) but we are focusing more on a teacher-centric approach to teaching and learning. Teachers are teaching Mathematics how they have learned and announced their learning strategies that have promoted their learning which may not work well for all of their students (Stitt-Goheds, 2001; Khanal, 2018). Shreya was advocating that the majority of the teachers in our community schools have learnt this level (Grade IX and X) before 15/20 years or more than that and they are following the similar strategies in their teaching rather than updating themselves which creates a mismatch in the teaching-learning environment provided by the teacher and the students’ expectation. “The mismatch between teachers’ teaching styles and the learning styles and strategies of students leads to frustration and lack of continued achievement in learning career” (Khanal, 2018, p. 4).

Many research like Henson (2004), Hou (2007), Stitt-Gohdes (2001) have supported that matching teaching-learning strategies can improve students achievement. However, the respondent (Dr. Math and Ghimire) of this study experienced that the current practices of teaching and learning Geometry theorem are less matched with student’s interest because of our way of facilitating the textbooks rather than to facilitate the students. Some participants (Ghimire and Shreya) in this study were arguing that “we are teaching the textbooks, not the students” which diverts the students’ interest from overall Mathematics and it is the same for the

Geometry theorems too. The educationist in Mathematics education (Dr. Math) was advocating the constructivist approaches in theorem learning where a teacher needs to provide enough learning environment for any student according to their capacity and level of learning. In the case of Geometry theorems, a higher number of teachers are proving most of the theorem themselves assuming that the theorems are difficult for the students and students just copy the proof from the teachers. Students are not getting the chance to create their ideas and logic while proving theorems.

Secondly, teachers are treating all the students equally which may not be enough for all the students, and Dr. Math was arguing that some students may need special effort also. One of the respondents, a student, (Liza) in this study who is also known as the good achiever in Mathematics was also arguing that she feels very difficult to understand the Geometry theorems from the board and is not able to prove them, but whenever she is taught individually and solves them herself with the guidance of the teacher, itis easy to understand and clear the concepts of the Geometry theorems. She was also focusing that the theorems are not so difficult for her to prove but she needs some individual guidance and dealing with the basic concepts. On the other hand, a so-called moderate student in Mathematics (Anisha) was arguing that her teacher focuses more on the high achieving students in Geometry theorems learning. This result shows that the way of the learning process and dealing with various learning activities differ from student to student (Callahan, Clark & Kellough, 2002). A teacher needs to be aware and able enough to provide enough and effective learning environment for each student in the classroom. One of the respondents in this study (Mr. Expert) was arguing that the teacher is all-in-all for the learning process as he/ she can create an enjoyable and fabulous environment for the

learners which can motivate them to actively participate in theorems learning of Geometry.

In this scenario, the researcher found that the teaching-learning practices in Geometry theorems and even in Mathematics is not learner-friendly in our context and a majority of the learners are not enjoying the theorems learning in Geometry. "Learning Mathematics is effective if students are exposed to construct or reconstruct Mathematical concepts. This implies that Mathematics teachers should rethink the existing teaching and learning strategies" (Khanal, 2018, p. 6). Several studies like Farkas (2004), Henson (2004), Hou (2007), Zeeb (2004) also have advocated the learner-friendly strategies where a teacher needs to demonstrate the flexible teaching styles and strategies where a learner can experience meaningful learning with active participation to empower themselves. In this sense, it is concluded that all the learners in the same class also do not prefer the same kind of teaching-learning strategies, some students may need extra support also and a teacher needs to focus on student-centred strategies rather than teacher-centred in teaching and learning Geometry theorems to get the desired and better achievement in it.

Internet and ICT tools in Geometry Learning

Internet is the vast ocean of information. It is being used by people daily for interacting with each other through social media, web surfing, online game, reading, and many more. Internet is also being used as a source for teaching material (Tutkun, 2011). The internet offers various opportunities for school students to learn mathematics. Kissane (2008) has discussed six types of opportunities namely interactive, reading interesting materials, reference materials, communication, problem-solving, and web quests. According to him, the interactive opportunity allows students to interact directly with mathematical objects. Reading interesting

materials allows the supplementation of available textual resources. Reference materials provide more extensive and accessible sources than usually available to students. Communication permits students to communicate with other students or with teachers about mathematics across existing barriers. Problem-solving opportunities are more extensive than normal classrooms can offer. Web quests provide structured investigational opportunities. In the context of Nepal, both students and teachers have acknowledged the importance and necessity of the internet in teaching and learning activities. However, the use of the internet in geometry learning is limited. According to Anisha (who is a hater of mathematics), the internet is making it easy to learn anything in the world. She claims that, with the help of the internet, students can clear their concepts and solve problems through You-Tube videos and Google. She has also used the internet in other subjects like social studies, science but has not used it in mathematics learning and geometry theorems. Liza (who is a good performer of mathematics) has also used Google to search and understand some questions, terminologies, and concepts of mathematics. Despite that, she is less familiar with the use of internet in geometry theorems learning. Even though Shreya (who has taught mathematics for more than 30 years) admits that the internet is very useful in learning geometry theorems, she has less used it in teaching geometry. Ghimire (who has taught mathematics for more than 27 years) has said that teachers can teach limited things in the classroom due to the time factor whereas students can explore unlimited things through the internet. According to him, students get a chance to learn the same thing in various ways. On the internet, they can read articles, watch short video tutorials. They can know the history and even the applications. According to Dr. Math (who is an educationist and an Associate Processor), the current generation of students spent a huge amount of their time on the internet playing with

their gadgets. He suggests, in such a situation if teachers can motivate them in using mathematical puzzles, mathematical games, and also if teachers can design any other platform using the internet where students can learn with fun then the internet can contribute a lot in theorem learning.

ICT is the umbrella term that includes any communicating devices or application encompassing radio, television, smartphones, tablets, laptops, desktops, computer programs, videoconferencing, teleconferencing, emails, etc. (Oye, Shalluku & Iahad, 2012). According to Dahal and Dahal (2015) teaching-learning activities, using ICT is an opportunity for learners and facilitators to develop, construct, innovate and explore the new ideas and knowledge of mathematics. They further claim ICT in mathematics classroom encourage students to develop problem-solving skills. Ghimire argued that ICT can foster higher levels of mathematical thinking, geometric thinking and helps to visualize abstract ideas. Hohenwarter, Jarvis, and Lavicza (2009) have also said that ICT can foster visualization and exploration of mathematical concepts (as cited in Bhagat & Chang, 2015). Geometry is the study of shape and space; it is composed of mathematical language and figures. It demands visualizing abilities, but many students cannot visualize (Guven & Kosa, 2008 as cited in Dahal, Shrestha & Pant 2019). Idris (2006) has also identified the visualization abilities of the students as one of the causing factors for the difficulty in learning geometry. According to Dahal, Shrestha & Pant (2019), ICT tools (such as GeoGebra) are better at visualizing geometric concepts than the static drawing on graph and whiteboard. Anisha has also mentioned her mathematics teacher uses GeoGebra in teaching Geometry and transformation. She remembered her teacher using GeoGebra to teach geometry theorems when she was in grade IX. She also remembered her teacher using a laptop to teach some chapters and clear some abstract

concepts in Mathematics. She shares that, her teacher used to show from the front desk and she including her friends had to observe from their seats. On the other hand, Liza has never experienced ICT in her school. Though Shreya acknowledged the role of ICT in geometry teaching, she has not used any online tools recently to teach geometry. Ghimire is convinced that ICT makes learning easy and is helpful in geometry learning. He also feels that the learning should be ICT friendly. According to him (Ghimire), with the help of ICT, teachers can display the figure making process in a sequential order which is helpful in giving the stepwise conceptual knowledge. Likewise, Dr. Math also claims that we can easily show the connections between the concepts and solve almost all the theorems of Geometry at the secondary level using ICT tools. He further claims that our teachers less use ICT tools in teaching Geometry in our schools which are causing difficulty in learning Geometry theorems.

Funkhouser (2003) found that students who have been instructed geometry with computer augmented activities have a better understanding of the geometrical concepts than students who have undergone traditional instructions. But, in Nepal, we are still practising the conventional “chalk and talk” approach in the mathematics classrooms (Sharma, 2016). Panthi and Belbase (2017) have also claimed that in Nepal, mathematics teachers mostly use traditional pedagogy such as lecture method and transmission approach. Likewise, Mainali and Heck (2017) write a teacher-centred, examination- driven teaching approach, which focuses on knowledge of facts and standard methods through drill and practice without the integration of ICT, is dominant in Nepalese high schools. Hence, it can be said that low or no use of ICT technology in geometry teaching is one of the causes of the poor performance of students in learning geometry theorems.

De-contextualization in Geometry Learning

Contextualization is the modern teaching approach that advocates teaching the subject matter by connecting it to the real context. It is one of the keys which helps students to connect their situations to their lesson (Reyes et al., 2019). In mathematics, contextualization refers to the teaching of mathematical problems that emphasize real-life situations (Yee & Bostic, 2014).

The learning in Nepali schools is based on textbooks, which have been prepared according to the school curriculum (Luitel, Dhukhel Experience). Moreover, during the preparation of the SLC/SEE examination teachers encourage students to practice new and challenging questions from the mathematics practice books. Teachers teach and students learn these textbooks of Mathematics to secure good marks in the exam. The examination-driven teaching approach is dominant (Mainali & Heck, 2017). Anisha, in her conversation with the researcher, said that study in her school in most of the subjects including Mathematics is exam-oriented. According to her, this might be the case in other schools as well. She further added that students are not much worried about knowledge and worried only about the exam. Liza seemed to be able to solve textbook geometry problems easily but she is still not able to connect them to her real-world. Sharing the past geometry learning experience Shreya and Ghimire said they used to memorize the theorems according to the theorem numbers like theorem 1, theorem 2, etc. Ghimire pointed out the lack of contextualization of mathematics saying the curriculum and teaching trend fail to connect mathematics with daily life. According to him, students learn a theory in textbooks, and the theory is implemented nowhere. Geometry was easy for Dr. Math during his school and he had solved all the problems from the geometry section in S.L.C. From the conversation of the researcher with his participant (students, teachers, and

educationist), it seems geometry learning in Nepalese schools is textbook-based and exam-oriented and there is a lack of contextualization.

Contextualization is a teaching process that connects lessons directly to a concrete application that will be appealing to students' interests (Perin, 2011). Math lab plays an important role to connect lessons directly to a concrete application with the use of solid materials and manipulative. A majority of the schools in Nepal do not have a Math lab, argued by Dr. Math. Some of the schools have the Math lab with very few teaching materials just to show that they have a Math lab. According to Anisha, her school did not have a special Math lab, but her teacher used to encourage them to make local materials such as prims, pyramids, other solid objects, etc. while teaching Mathematics. Those materials were used to be kept in the staff room and classroom. Though her teacher used to teach some of the chapters of geometry using teaching materials, she found that the materials were not sufficient for her to clear her concepts on those topics. Students didn't use to get the chance to play and perform their activities with those materials. Liza's school has a Math lab; however, she has never been there and her teacher has not used any teaching materials to teach geometry. Shreya thinks a Math lab is very essential to given conceptual knowledge and she has also started working in it in her school. She believes most of the teaching materials should be prepared by the students using local materials. Some of the materials can be bought. Ghimire has agreed the less use of concrete and local teaching materials in teaching geometry is one of the causes for difficulty in learning geometry. He believes that teaching without teaching materials is meaningless. He thinks instead of blaming school and school administration for not allocating budget for teaching materials, mathematics teachers should be laborious to prepare teaching materials themselves and involve students in the preparation of the local materials.

During the visit to some of the schools in Kathmandu valley, Dr. Math has seen Math lab in a cupboard with very few materials. According to him, the materials are not sufficient even to give basic concepts of geometry. He further claims, in the name of concrete material, we are just using a geometry box as a teaching-learning material in teaching-learning geometry, and there is very little use of concrete and locally prepared materials. Lubben et al. (1996) have argued that concrete materials are beneficial for a contextualized lesson, but the teaching approach should be converted to a new approach to getting the optimal benefit of contextualization.

Contextual Teaching and learning are a conception of teaching and learning that helps teachers relate the subject matter to real-world situations and motivates students to make connections between knowledge and its applications to their lives (Berns and Erickson, 2001). Anisha has been told by her mathematics teachers that each topic and concept of mathematics exist somewhere in the real field. However, Anisha never believed in it from her inner heart because she never found it practicable though she solved many problems of Math book. In her opinion, Mathematics and Geometry theorems should be designed in such a way that students feel it easy and practicable. Shreya has focused on making Mathematics more practical based. She doubts either the teachers lack technical or subjective skills, or they just merely teach as a job which is resulting in low performance of students in geometry. Ghimire has advocated for applied mathematics. According to him, if we go in an applied way, students will acquire a permanent image of the concepts, in which students can use the Mathematical concept and ideas directly in their daily life. According to him, the latest curriculum has given little space for practical application linking mathematics with real life. He has taken it as a positive step and believes that the new curriculum which will be formed after five or ten years and we need to give more space for the

applied part. Dr. Math has also felt the necessity to connect mathematical concepts to the real world. According to him, we are solving the problems of mathematics and mathematics is not solving our problems. That means we are still not able to apply mathematics in our daily life.

Various learning approaches have been discussed in various literature to implement contextual teaching and learning. Cooperative learning is one of the approaches (Berns & Erickson, 2001). It is an approach that organizes instruction using small learning groups in which students work together to achieve learning goals (Holubec, 2001). Group work is a type of cooperative learning. Anisha and Lize both have argued that their teacher involves them in group work by mixing high achievers and low achievers (a heterogeneous group of students). Shreya has said a heterogeneous group will be beneficial for geometry learning. Ghimire claims individual learning can never be as effective as group work but he has found misconceptions among some of the parents and teachers about group work. Dr. Math is also in favour of group work but he has seen many obstacles in implementing group work during his visit to many schools. He has seen more than 100 students inside the small classroom with 6-7 students sitting on the same bench. The researcher himself has found 74% of the participants of the quantitative study saying that their teacher is not using group work in geometry teaching. Language and culture also play a vital role in contextualization. According to Luitel (Dhukhel experience), mathematics books are written in Nepali language only but our country (Nepal) is a multilingual and multi-ethnic community Language and culture which requires multiple perspectives in Mathematical representations which are also acting as a barrier in contextualizing geometry.

From the above discussion, geometry seems to be decontextualized in Nepal. It is one of the causes of difficulty in Geometry theorems learning.

Impact of Teachers' Training on Geometric Theorem Learning

Professional development is a major part of teaching and learning geometric theorems in school level mathematics. Training and the refreshment Program are a major part of the professional development of teachers. In the context of Nepal, the current situation shows that the overall outcome of mathematics at the school level is lower than the other subjects. The government divided the various governmental organs/acting bodies to provide effective training and professional development to the teachers. The governmental acting organ such as Curriculum Development Centre (CDC), Educational Training Centre (ETC), Distance Education Program, etc. are providing the training, refreshment Program, and the certification of training for the teachers at community schools.

There are two major types of professional training for teachers in Nepal (Post job requires training and in-service training). The Certified Formal Education from university with the educational framework and pedagogical content is the post job requirement for teachers in the Nepali education system. The Education Act (1971) of the Government of Nepal has made the Educational and professional training a compulsion for being a teacher in Community schools of Nepal. During the professional period, the governmental acting body of the Ministry of education provides the various types of professional development training for community school teachers. Teachers Professional Development (TPD), refreshment training, Demand-based training, etc. are the professional training for teachers during the service in Nepal. The training and refreshment package provides strong support for teachers in content and pedagogical skills.

Teaching and learning geometry in School education is one of the major challenges for learners as well as teachers. The pedagogy selected by the teacher plays a vital role in learning geometry where the professional training could change the trend of teaching geometry inside the classroom, argued by Mr. Expert and Mr. Ghimire argued that his journey as a mathematics teacher was very challenging for teaching geometry inside the classroom in his starting days of teaching. Lack of training and professional ideas, his classroom pedagogy was similar to his schooling through which he had learnt geometry. Throughout the journey of professional teachers, his classroom pedagogy and teaching strategies changed over time as a part of the impact of training. Without the clear conceptual framework of content knowledge, pedagogical skills, and professional dedication the teaching and learning process would not be much effective. Sharma and Nuttal (2008) discussed that professional training increases the efficiency of teachers where the teacher gets the chance of self-correction to deliver the content. The discussion on training would be the transition for teachers to transform from one practice to a new trend for the betterment of the teaching and learning process.

Training and refreshment package provides a clear vision and defence for the effective ways for teaching and learning process. Aziz & Akhtar (2014) had made their argument that trained teachers showed a significant difference in pedagogical competencies, management, and assessment competencies, and research competencies. In this context, Mr. Expert argued that, if the teachers are trained enough then they can easily provide a clear conceptual framework of geometry for their learners. The training would provide multiple choices for teachers to deliver the content inside the classroom, which increases the competencies of learners. Mrs. Shreya argued that training is a powerful mechanism for the correction of teaching

and learning strategies during the professional journey. Her reflection and experiences show that the teaching and learning geometry of her starting days was very complicated where most of the time she used to memorize the content for her learners. After the professional journey and professional training, her pedagogy changes towards the correction where the learners were given the chance to learn the geometric content in multiple ways. The conceptual frameworks were given more emphasis rather than memorization, argued by Shreya in her teaching practice and added that geometric contents are quite different from other contents in mathematics. Mr. Expert put his thought about the training that pre-service and in-service training and remedial packages are most required for being a professional teacher. From the view of a curriculum designer (Mr. Experts), the training plays an effective role where the changing nature of curriculum would refresh for a teacher who is spending a long time on his professional journey.

In the case of our classroom, having multicultural, multilingual, and different social and economic aspects the teachers need to be aware regarding pedagogical correctness where the pedagogy should meet the requirement of each learner. Dr. Math argued that teachers have to give values to all learners. In this condition, teachers are facing difficulties to deliver content where the training and discussion on Professional Learning Community (PLC) would provide effective correctness for teachers. Mr. Ghimire remembers his past hood of teaching journey where he would teach geometry only to score marks on board exam for learners by memorization but during running towards the professional journey, the training and professional development changed his prospects toward the conceptual knowledge of learners. The training and PLC discussion would be a turning point to teach geometry inside the classroom, he (Ghimire) argued. Teachers play a vital role in developing and

maintaining classroom engagement in education where teachers reach out to the culture of learners and support their connections with formal education, which would facilitate and encourage professional development (Smith, 2019). The teacher might be from one culture and s/he might be teaching in another culture where the training and professional development make it easy for teachers to connect with new culture and environment.

The professional discussion through the training package would be an effective trend for learning geometry. Dr. Math argued that the trend of training in our community is not for only participation, but its effective implementation is very necessary. The trend of research and finding fact in our practice is very low where the investment is being less effective, he further added. The teachers have to be self-responsible for their correction themselves. The professional correction and pedagogical strangeness are the turning factors for teachers argued by Ghimire. The training and support for professional groups and their implementation increases the competencies of learners. Mr. Expert remembers that the trend of learning geometry at the school level of most of the recent teachers is quite traditional where they just learnt geometry for memorization and routine-based practice. He added that the trend of innovations in education would adopt by the teacher through training and refreshment where the trend of teaching-learning should change from their schooling of school education towards the innovations. Ghosh (2016) argued that "all the extra-education Program which the teacher receives at different institutions by way of orientation or refresher courses and all the travels and visits which he/she undertakes" (p. 146). In this scenario, the researcher concluded that teaching is the profession where teachers should change throughout the completely professional life where the

change and new adaptation is provided by the training, refreshment package, and discussion on PLC.

As the common thought of all participants i.e, teachers, educationist, and curriculum officer of my research, provide evidence that the government of Nepal is investing large economic and human resources for the professional development of community school teachers. Geometric theorems are the logical sections of mathematics where the sequence of logic is interrelated. As compared to other section of mathematics, geometry is highly focused on logic and critical thinking where the algorithm process is different than other section of mathematics. The aim of professional development is for the betterment of the teaching profession which increasing the logical reasoning and critical thinking ability of learners. Jacob, Hill & Corey (2017) raised that, "the professional development is designed to improve teachers' mathematical knowledge for teaching and to enable them to elicit more student thinking and reasoning during Mathematics lessons" (p. 13). The theorems of geometry are interrelated to each other throughout the logical sequence. A well-trained teacher can easily relate the logical sequences of theorems in the right track where the critical reasoning of learners is highly focused. Mr. Ghimire & Mrs. Shreya have argued that they used to teach geometry at the early age of the teaching journey for solving routine-based problem solving but the professional training and discussion made them create a logical sequence and critical thought on learners during learning geometry. The single thought could not change the trend from the tradition where the discussion on PLC may raise the voice of suppressed which may enhance the conceptual understanding of a learner.

Chapter Summary

This chapter has incorporated the intensive analysis and interpretation of qualitative data. The interpretation was done to address the need for a second research question about why students feel problems in learning Geometry theorems found in the first phase study. The interview was collected separately from the students, teachers, an educationist, and a curriculum expert and analysed based on their experiences in learning Geometry theorems in this chapter.

The discussion in this chapter shows that the nature of teacher, less connection of the content to the context, conventional lecture-based teaching-learning strategy, the teacher-centered approach of teaching and learning, less use of technologies in the learning process and lack of enough and effective teachers training are some major problems in learning geometry theorems in our context. The experiences of the respondent of this study show that the majority of the students cannot express their difficulty in front of their teachers due to the strict nature of the teacher. Similarly, the contextualization of the context of geometry or overall mathematics is found less in our context which less motivates school students in the theorem learning process. The less connection of textbook problems to the learners' real-world problems creates boredom and anxiety in the learners to study geometry. The traditional approach of teaching where the theorems seem to be memorized is also found as a problem creating agent in learning geometry theorems. Teachers are focusing more on the high achieving students in the geometry section which demotivates low achiever students in learning geometry. Likewise, our teaching-learning approach is teacher-centric which needs to transform into the students-centric approach. Mr. Expert in this study argued that the teacher needs to create a healthy learning environment inside the classroom where each student needs to participate in the learning process. They also focused on the use of ICT in teaching geometry which can contribute in visualize and

clarifying the students' concepts. The teachers and the expert in this study argued that a majority of the teachers are focusing on routine-based problems at the secondary level just to score so-called good grades in examinations, but they lack in giving priority to the understanding of the concepts of the particular problem. Students are following the rote memorization technique and algorithmic problem-solving approach which is not able to address the conceptual understanding of the students in geometry. The conversation with the teachers and experts also shows the lack of effective and professional training packages for the teachers to teach geometry and they also argued that a large number of teachers do not take the skills learnt from the training package to their classrooms. It is also required to motivate our teachers to use the students friendly teaching-learning approach in their classrooms and modify their skills as per the situation of the learners. In this situation, there is a large room to modify our teaching-learning practices from the level of the school, teachers, students, and policymakers to get the desired outcomes from learning geometry and overall mathematics.

CHAPTER VI

RECAPITULATIONS, CONCLUSION AND RECOMMENDATIONS

In this explanatory sequential mixed-method study, the researcher has surveyed for the quantitative study and presented the result of the statistical tests in chapter IV, and the qualitative data collected through interviews was analysed in chapter V. This chapter incorporates with the recapitulation of this study followed by the conclusion. I have also presented the implication of the study for the students, teachers, and area of the policy before winding up this chapter with final remarks. Moreover, this chapter incorporates the recommendations at the end.

Recapitulations

The geometrical component of the school mathematics curriculum, in most countries, provides not only an opportunity to build learners' spatial and visualization capabilities, but it is also a key vehicle for developing their capacity for deductive reasoning and proving (Battista, 2007; Fujita & Jones, 2007). This study aimed to figure out the problems in learning Geometry theorems in school Mathematics. To serve the need of this research study the researcher firstly conducted the quantitative survey with 270 participants' students of Grade IX and X from 8 community high schools and 27 teachers of the same level from the same schools. The statistical data were analysed in SPSS 25th version to get the desired outputs through different tests. The findings of the quantitative analysis analysed from Chapter IV is presented below:

From the quantitative analysis of the data collected from the 270 students, the following problems are found in learning Geometry theorems in secondary schools from the perspective of the students.

- Students feel Geometry theorems are less practicable in their real life.
- Theoretical learning seems difficult than solving problems in Mathematics.
- Teachers use fewer ICT tools such as mobile, laptop, desktop computer, etc. to clarify geometry theorems.
- Teacher less response to all the students in Mathematics class.
- Mathematics teacher focuses less on group works while proving geometry theorems.
- Students do not have good access to the internet at their school to find support materials for learning geometry theorems.
- Students do not have the facility of Math Lab at their school which supports them in learning geometry theorems.
- Students feel easy to learn Geometry theorems from their friends which indicates that they are feeling less comfortable learning from their teachers.

Similarly, the following findings are observed from the different tests of the SPSS outputs on students' data:

- It is found that the problem faced by the secondary students in learning geometry theorems is not affected by their gender.
- It is found that the problem faced by the secondary students in learning geometry theorems is affected by their grades.

- The correlation between the content of Geometry and teaching-learning activity is slightly positive which shows that the role of content in teaching-learning activity is less connected.
- There is a very weak positive relationship between the content of Geometry and evaluation technique which shows that the relation between these two variables is less connected.
- There is a moderate relationship between teaching-learning activity and school administration which shows that the school administration is also responsible for teaching-learning activity.
- There is a moderate relationship between teaching-learning activity and evaluation techniques show that evaluation teaching-learning activity is responsible for evaluation techniques.
- There is also a moderate relationship between school administration and evaluation techniques which shows that school administration is responsible for the evaluation techniques.

Similarly, from the quantitative analysis of the data collected from the secondary mathematics teachers, the following problems are found in learning Geometry theorems in secondary schools.

- Students feel difficult to find the connection between the theorems.
- Students feel that geometry theorems are more complicated than other content in mathematics.
- Students find it difficult to translate the word problems into the figure.
- Students' feel that geometry theorems are less practicable in their real life.
- Students feel easy while proving geometry theorems theoretically.

- The poor foundation of students in basic level mathematics poses problems in learning geometry theorems.
- Students feel difficult to solve the geometry theorems without the guidance of the teacher.
- Geometry theorems in mathematics less match with the interest of students.
- Students' have psychological fear of the topic "Geometry theorems".
- Because students' less practice results in poor performance in learning geometry theorems.
- Most of the students prefer to leave some parts of geometry assuming that does not affect their letter grading in the examination.
- Our school education system mainly focuses on the scores in the examination that motivate students for rote memorization of theorems.
- Students do not get the opportunity for sufficient discussion because of the large number of students in the classroom.
- Manipulative geometrical materials are less available in our school.
- Teachers have not got effective training to teach geometry theorems.
- Teachers are less familiar with the ICT tools which can be used to teach geometry theorems.

Similarly, the following findings are observed from the different tests of the SPSS outputs on teachers' data:

- It is found that the problem faced by secondary students in learning geometry theorems is not affected by the teaching experiences of teachers.

Findings from the Second Research Question

Moreover, the researcher conducted interviews with six participants (2 students, 2 teachers, 1 educationist, and 1 curriculum expert) to find the reasons behind the problems in learning Geometry theorems in secondary schools. The researcher has interviewed in three different phases to keep the prolonged engagement with the participants and to get the desired outputs (data) from them. The collected qualitative data from the interview are analysed in Chapter V under six different major themes. The findings from the students' interview are followed by the findings from the remaining participants. The findings of the qualitative analysis are presented below where findings from the students' interview are followed by the finding from the teachers, educationist, and expert.

The following findings are analysed from the students' experiences in learning geometric theorems.

- Students were influenced and encouraged to memorize the theorems only for examination purpose. Most of them felt that Geometry theorems are more difficult in comparison to other sections in Mathematics. They did not see the practical use of Geometry theorems in real life. So, most of them study mathematics with the wishes of just to pass the examination.
- Majority of the students try to copy the proof/ solutions of the theorems from their friends or from other sources (internet) rather than to prove themselves because of lack of basic concepts and they don't feel much comfortable consulting with their teachers also.
- Teachers are not paying equal attention to all the students in class while teaching Geometry theorems. They are focusing more on the so-called good achieving students than the slow and low achieving learners. This

partiality in students discourages them to learn not only Geometry theorems but overall Mathematics.

- Teachers are not using enough manipulative materials or ICT tools in Geometry classes to clear the basic concepts of the students which leads to them failing to attempt and understand the theorem sections.
- Students have psychological fear about Geometry theorems that it is the most difficult section in Mathematics. So, a higher number of students want neither to learn nor practice the theorems while learning geometry. The role of a teacher and the friend circle of the student is highly responsible to establish this fear in the thoughts of an ordinary student.
- Ordinary students are not interested in learning Geometry theorems because of its abstract nature and teachers are always in rush to complete the course and teach many theorems in a single class which flies over the students' heads without any understanding.

The following findings are analysed from the experiences of teachers, an educationist, and a curriculum expert in learning geometric theorems.

- Teachers are focusing equally on all the students in class in Geometry theorems learning in the beginning but while preparing for the SEE and board exams they focus more on the high achieving students in this section assuming that low achieving students may feel more difficult in this section and required a lot of time to practice which they can give to other easier sections.
- Teachers feel a lack of content-based training in Geometry for the secondary level which can support in theorems teaching and learning.

They also feel the lack of ICT skills and Math lab in their schools which can support to clear the basic concepts of Geometry.

- Teachers are not able to deal with and treat individual students because of the large number of students in a single class in community schools. They also found that the students are less interested in Mathematics learning which is creating a problem in learning not only Geometry theorems but whole Mathematics.
- Teachers found Mathematics as content loaded subject because of which they are not able to give their desired time for students in teaching-learning Geometry theorems.
- Teachers themselves found that they have a less constructivist approach in teaching-learning Geometry theorems which motivates students in rote memorization of the steps without understanding.
- It is also found that the teaching-learning strategy is less connected with the learners' context which demotivates students in learning Geometry theorems. A majority of the teachers are teaching in the same way how they have learnt which is not able to address the need and desire of the current students.
- From the teachers' experiences, some students in each secondary class are found in the level 3 (formal deduction) as in Van Hiele level of Geometry understanding where students are able to understand the interrelationship and role of geometric terms, axioms, postulates, definitions, theorems and able to develop a proof for any geometrical statement and can distinguish between the statement and its converse can be made.

Conclusions of the Study

Geometry is a beautiful and artistic portion in Mathematics where the theorems are the milestones in it. Most of the concepts and logic in Geometry are the product of simple to complex theorems. We can see the concepts and shapes of Geometry very easily in our real world. In this sense, I can say that we have a very close relation with Geometry and Geometrical shapes but on the other hand, we are known only about the textbook Geometry, full of illusions and abstractness which we are failed to connect with the real existing Geometry. I have found very few research studies related to Geometry theorems which seem like a hurdle in school Mathematics of Nepalese curriculum. In the context of Nepal, Geometry theorems have been a very big issue for the school students in learning Mathematics. Geometry is a part of Mathematics curricula from the lower primary Grades to the University level, but the theorem learning starts only above the basic level. However, Geometry learning is more emphasized in our curricula but the achievement in it is not acceptable. The teaching-learning strategies of our context are not able to clear the basic concepts of students from the lower level of schooling. Students are failed to conceptualize the different concepts of Geometry.

School Geometry is considered as the area of Mathematics which can develop logic and critical understanding in students. The theorems in Geometry are more responsible to develop the creativity and reasoning skills in students but this section is taken as a curse in Mathematics curricula in our context. Most of the learners are avoiding Geometry theorems in their study. From the group of high achieving students also very few prove the theorems with their interest and the remaining solve it only to score marks/ Grades in examinations. It is found that students are avoiding Geometry to learn at the secondary level because of the lack of basic concepts and

conceptual understanding in it. This is because of the conventional approach of teaching and learning in school Mathematics.

As a teacher and a student of Mathematics, I have also faced so many difficulties in teaching and learning Geometry theorems. Our one-way teaching practice (teacher teach and the students follow in instruction without raising any questions) in Mathematics is not able to address the students' creativity and motivating students in the reproduction of knowledge. Students are not finding any connections of the theorems to their real context. Even many teachers are also feeling this portion as a difficult section to teach. While collecting the qualitative data, it is also found that many teachers are failed to prove the new theorems when they encountered it for the first time. I too have some bitter experiences in this case. Sometimes it is very difficult to find the connections between the property of the triangles, quadrilaterals, lines, circles, etc. while proving the Geometry theorems. The reason behind the challenges in proving Geometry theorems is our content loaded curriculum because of which a teacher is not able to provide enough time for each of the student.

The second reason is our instructional teaching strategies which emphasize more on examinations rather than understanding and motivate the students towards rote memorization. Similarly, the less use of teaching materials and ICT tools which helps students to visualize their concepts and clear their illusions in Geometry. In spite of creating a better learning environment for the students in learning Geometry theorem, we choose the selected high achieving students to teach this portion and neglect the low achieving ones by blaming them as 'theorems are only for the so-called talent students'. Such an environment in any classroom may distract the students from Mathematics learning and may develop frustration, boredom, and

irritation towards the subject. In the interaction with different types of people who have direct linkage with secondary school Mathematics in the interview, it is found that the community schools in our context do not use activity, projects, practical and field works type of stuff in teaching and learning Mathematics.

As the geometry theorems are to be proved with correct figures by the appropriate use of statements and reasons, students feel geometry theorems are more complicated than other content in mathematics. Many students feel complications in translating the word problems into the figures. As a result, they seek the guidance of their teachers to solve the geometry theorems. During their teaching experience, participants have also found some of the students showing great interest in geometry. According to them, few talented, self-motivated, and mathematically gifted students feel the theoretical proof of geometry theorems easy. I, as a researcher, found them as level 3 (formal deduction) students according to Van Hiele level of understanding Geometry. On the other hand, for the average and fewer achievers, theoretical proofs are harder as compared to experimental verifications.

This sequential explanatory mixed-method research study was able to address the aroused issues in learning Geometry theorems and able to list out the problems in learning Geometry theorems in secondary schools. Likewise, the study was able to provide the possible reasons behind the problems through interviews which were collected from the survey study.

Recommendations

As a researcher of this study and by standing on the data analysis and findings, I have some significant recommendations for the institutions, teachers, curriculum developers, and policymakers with including further research possibilities.

For the Institutions

- It is found that there is a lack of a Math lab in most of the schools in this survey study. The schools are expected to arrange/ prepare a Math lab for the school students which can help in visualization of the concepts and give enough space for the students to create new knowledge with the experiments on the Mathematical tools.
- Similarly, schools do not have good access to the internet for the students' use to search the supportive materials for learning procedures. As the internet is being the most powerful medium for learning anything through different sites. The use of the internet in learning can give multiple flavours of solving and proving techniques. It can be more interesting and enjoyable for the majority of the students. Therefore, internet facility should be provided for the secondary students in schools for their better understanding and good achievement.
- Schools need to arrange topic and level-specific training programs for both pre-service and in-service teachers in Geometry. They are to be made aware of students' learning strategies and make them able to design the possible strategies which can match his/ her students' expectations and fill the gaps of need in learning Geometry theorems.

For the Teachers

- As students feel Geometry theorems are less practicable in their real life. Teachers need to connect the textbook problems to the students' real-world context as far as possible. Teachers can make students understanding with some real-world examples also, as we can easily find the Geometrical concepts in our real-world practice.

- As theoretical learning seems difficult than problem-solving in Mathematics. A teacher needs to be able enough to provide multiple ways of proving strategies to the students so that they can easily understand the meaning and ways of proving techniques from different ways and can be able to generalize in other methods also.
- It is found that teachers are using fewer ICT tools and manipulative geometrical materials in Geometry classes which can clear the basic concepts in Geometry. By understanding the present scenario of students and study in the 21st century a teacher needs to update own-self and need to be able to give ICT-friendly classes and maximize the use of materials while teaching Geometry.
- It is also found that the teachers respond less to all the students in class while teaching Geometry theorems. It is not like a less achiever in other content of Mathematics may not achieve a good mark in Geometry theorems. And also, if a teacher gives less priority to the low achievers in any area while teaching then the student may feel inferior in the class and can be demotivated from Mathematics learning. So, a teacher needs to treat enough to all the students in learning any area of Mathematics.
- From the quantitative (first phase) study, it is found that the Mathematics teachers less focus on group work while teaching Geometry theorems. Many research shows that anything can be learnt easily through collaboration and interaction between people than learning individually. Therefore, the teachers are further expected to try to let the students learn in different groups and let them reflect in their dealing with Geometrical problems. The teacher can pose the problems in a group to find multiple

ways of dealing with that problem and later facilitate them with their dealings. The teacher also needs to show friendly behaviour to the students so, that they can put their queries and difficulty with the teacher and can show their creativity also. Students should not be bind in the limited area given by the teacher or a textbook. We need to leave them free to construct their knowledge with collaboration in the given curriculum frame. Teachers can focus on activity-based and project-based learning in Geometry which can motivate the students in theorems learning too.

Recommendation to Policy Makers and Curriculum Developers

- It is found that Geometry theorems are not able to grab the students' interests in learning and found as the most abstract section in secondary school Mathematics. Therefore, the curriculum designer and policymakers are expected to present the theorem section in an easier manner and interesting ways as far as possible. They can connect it to the real-world practice as far as possible to make it more understandable so, that students can feel that they are solving their problem through theorems and may motivate in its learning.
- Currently, there are two ways of proving theorems in Geometry and they are theoretical and experimental methods with very strict steps and methods (like making tables and following the same rules of textbooks). As we aim to search for the proof/ solution of any statement or a problem in Geometry. Students should be given free to prove the theorems from multiple ways in the curriculum only. There must be some space for the students which helps them to create/ construct new knowledge in Geometry theorems.

Recommendation for the Further Research

As a researcher, we cannot include all the aspects of issues in a single study. In the same way, this research study is unable to cover all the emerging things and issues around Geometry theorems learning. I have some recommendation for further study:

- The present study is conducted to find the problems in learning Geometry theorems. As a researcher, firstly, I recommend you conduct a study to find the possible strategies that could solve those problems and make learning Geometry theorems easier than the current practice and get better achievement.
- The present study can be replicated among the secondary school students in other theorems proving area of Mathematics like Vector, Co-ordinate, and Algebra, etc. It would be beneficial to have other data that could be compared with the findings of this study.
- Further study is suggested to compare and contrast the influence of Geometry with other areas in Mathematics. The results would reveal whether there is a difference in learning theorems in different topics of Mathematics.
- This study is conducted only among the students at community schools. Further research is recommended to conduct among the institutional schools and with an equal combination of both community and institutional schools.
- Because of time and financial constraints, this research study could incorporate the sample respondents of community schools of Tokha Municipality, Kathmandu. In this situation, there are some circumstances

to generalize the results and findings to the broader population may be to the whole district, zone, or country. So, the future researcher can take a large sample so that the result could have been generalized to a wide range of populations.

- The researcher has chosen the area Geometry theorems for this study. In the same way, other researchers are recommended to find the issues in different areas of school Mathematics which can help to uplift our school Mathematics education up to the international level.

Limitations

- Due to the pandemic situation of COVID-19, the researcher was not able to collect the data in the previously planned mode (physically) and collected through online mode.
- It was very difficult for the researcher to connect with the students at community schools at the beginning of the survey through online mode as many of them do not have good access to the internet.
- The record-keeping system in NEB is found to be not systematic by the researcher as it took several visits to get the data of 2073 and 2074.
- Due to the pandemic, the researcher was not able to reach the students in the desired time and need to wait for few months to collect the data through online mode which consumed more time to complete this study.

My Learning from this Study

This study was a milestone in my research career and acts as a turning point that transformed me from an ordinary reader/learner to a researcher. When I was thinking about conducting this study, I was not experienced with the methods and design of the research study. Before starting this research, I was not aware of the

actual meaning and importance of the research study and used to think it, just as a collection of sentences and literature. In the beginning days of my master's study, I was encountered with many jargons in research which were clarified from multiple academic writings and my teachers. As I had studied a few quantitative and qualitative theses, at first, I was in dilemma about the choosing methodology of this research study. I have learned different methods of research design and found the mixed-method study is the best fit in my case.

As I commenced my research study, gradually I began to realize, doing a research study is not like writing a novel with a careful selection of beautiful words where the writer can create the characters and events according to his/her wish, give suitable direction and an exciting climax.

The data collection and analysis procedure was another insightful learning for me where I had experienced survey and interview methods along with the formation of research tools and their refinement. The interaction with different intellectual peoples in this journey gave me positive vibes and insightful learning which I can feel in myself. The interviews with resourceful personalities increased my insights into what mathematics teachers, educationalists, and students think about geometry teaching and learning in our schools. Through these interviews, I also learned more about the past and present situation of geometry teaching and learning in Nepal.

The analysis and interpretation of collected data from both quantitative and qualitative manner were a bit challenging for me at the beginning of this study. The use of technical software like SPSS in the research study was another learning for me from this study. As my supervisor encouraged me to produce the first draft of my study myself, I did an intensive study and produced the first draft with my single effort. From this, I have learned that motivation and encouragement also matter a lot

to fulfil any task for any student. I have revised my writing in multiple phases after the deep observation of my supervisor who was always by my side in this study.

Finally, as a concluding paragraph, I have learned so many soft skills like use of technology in research, way of designing the questionnaires, way of taking an interview, interpreting data, and presenting own self as a researcher. This research not only fulfilled the requirements of my degree but brought many changes in me as a researcher and a learner in Mathematics education. Last but not the least, I learned that learning is a never-ending process.

Chapter Summary

This is the final chapter in this research study where I have included the discussion of the major findings of the data collection and interpretation from both quantitative and qualitative forms. Similarly, the major conclusion of the study with the recommendations for the institutions, teachers, policymakers, and curriculum developers. Besides, the further possibility for research in this area has been included.

REFERENCES

Abidin, Z. Z., & Abu, M. S. (2011). *Alleviating geometry levels of thinking among Indonesia Students using Van Hiele Based Interaktive visual tools*. https://www.eprints. utm.my/14915/1/Alleviating_Geometry

Acharya, M. S. P., Metsämuuronen, J., & Koirala, S. (2011). *Mathematics achievement in NASA 2011*. NASA, Nepal.

Akhter, N., & Usmani, A. A. (2018). Analysis of Secondary School Students' Achievements in Geometrical Part of Mathematics. *Journal of Educational Research (1027-9776), 21*(2).

Al-ebous, T. (2016). Effect of the Van Hiele Model in Geometric Concepts Acquisition: The Attitudes towards Geometry and Learning Transfer Effect of the First Three Grades Students in Jordan. *International Education Studies*, *9*(4), 87-98.

Alex, J. K., & Mammen, K. J. (2014). Gender differences amongst South African senior secondary school learners' geometric thinking levels. *Mediterranean Journal of Social Sciences*, *5*(20), 1908.

Antink, S. B. L. (2010). *Geometry success, brain theory, and community building*. Fielding Graduate University.

Armah, R. B., Cofie, P. O., & Okpoti, C. A. (2017). The Geometric Thinking Levels of Pre-service Teachers in Ghana. *Higher Education Research*, *2*(3), 98-106.

Atebe, H. U., & Schafer, M. (2008). Van Hiele levels of geometric thinking of Nigerian and South African mathematics learners. In *Proceedings of the 16th*

Annual Conference of the Southern Africa Association for Research in Mathematics, Science and Technology. Maseru: SAARMSTE.

Aziz, F., & Akhtar, M. M. S. (2014). Impact of training on teachers competencies at higher education level in Pakistan. *Researchers World*, *5*(1), 121.

Baker, J. A. (2006). Contributions of teacher–child relationships to positive school adjustment during elementary school. *Journal of School Psychology*, *44*(3), 211-229.

Battista, M. T. (2007). The development of geometric and spatial thinking. *Second Handbook of Research on Mathematics Teaching and Learning*, *2*, 843-908.

Battista, M. T., & Clements, D. H. (1995). Geometry and proof. *Mathematics Teacher*, *88*(1), 48-54.

Belgheis, S., & Kamalludeen, R. (2018). The Intention to Use GeoGebra in the Teaching of Mathematics among Malaysian Teachers. *Malaysian Online Journal of Educational Technology*, *6*(1), 109-115.

Bergman, M. M., & Coxon, A. P. (2006). The quality of qualitative methods. *FORUM: Qualitative Social Research, 6*(5), Art. 34.

Bernard, H. R. (2017). *Research methods in anthropology: Qualitative and quantitative approaches*. Rowman & Littlefield.

Berns, R. G., & Erickson, P. M. (2001). *Contextual teaching and learning: Preparing students for the new economy* (Vol. 5). National Dissemination Center for Career and Technical Education.

Bhagat, K. K., & Chang, C. Y. (2015). Incorporating GeoGebra into geometry learning-A lesson from India. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(1), 77-86.

Birch, S. H., & Ladd, G. W. (1998). Children's interpersonal behaviours and the teacher–child relationship. *Developmental Psychology*, *34*(5), 934.

Bloom, B., Englehart, M. Furst, E., Hill, W., & Krathwohl, D. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* Longmans, Green.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn: Brain, mind, experience, and school*. Pearson.

Brown, A., & Dowling, P. (1998). *Doing research/reading research: A mode of interrogation for education*. Falmer Press.

Callahan, J. F., Clark, L. H., & Kellough, R. D. (2002). *Teaching in the middle and secondary schools* (7th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.

Central Bureau of Statistics. (2011). *A brief report on National Census 2011*. Central Bureau of Statistics, Nepal.

Clements, D. H. & Battista, M. T. (1992). *Geometry and spatial reasoning*. In D. A. Grouws (Ed), Handbook on mathematics teaching and learning. (pp. 420-464). Macmillan.

Creswell J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Sage.

Creswell, J. W. (2003). *Qualitative, quantitative, and mixed methods approaches*. Pearson.

Creswell, J. W. (2015). *Research design: Qualitative, Quantitative, and Mixed Method Approaches* (5th ed.). Pearson.

Croasmun, J. T., & Ostrom, L. (2011). Using Likert-Type Scales in the Social Sciences. *Journal of Adult Education*, *40*(1), 19-22.

Crosnoe, R., Johnson, M. K., & Elder Jr, G. H. (2004). Intergenerational bonding in school: The behavioural and contextual correlates of student-teacher relationships. *Sociology of Education*, *77*(1), 60-81.

Dahal, B., & Dahal, N. (2015). Opportunities and challenges to use ICT in Nepalese Mathematics classroom. In *Proceedings of Second National Conference on Mathematics Education* (pp. 50-52).

Dahal, N., Shrestha, D., & Pant, B. P. Integration of GeoGebra in teaching and learning geometric transformation. *Journal of Mathematics and Statistical Science (ISSN 2411-2518)*, *5*(12), 323-332.

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of teacher education*, *57*(3), 300-314.

Dhakal, D. P. (2017). *Students' engagement in learning mathematics: A mixed methods study of secondary level students* [Unpublished dissertation]. Kathmandu University, Dhulikhel, Nepal.

Dooley, D. (2004). *Social research methods* (3rd edition). Prentice-Hall of India.

Downey, J. A. (2008). Recommendations for fostering educational resilience in the classroom. *Preventing School Failure: Alternative Education for Children and Youth*, *53*(1), 56-64.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*(1), 109-132.

Edmondson, D. R. (2005, April). Likert scales: A history. In *Proceedings of the 12th conference on historical analysis and research in marketing (CHARM)* (pp. 127-133).

Educational Bulletin, (2019). *Educational review office*. Sanothimi, Bhaktapur, Nepal.

Educational Review Office. (2016). *Performance audit report*. Sanothimi, Bhaktapur, Nepal.

Erdoğan, T., & Durmuş, S. (2009). The effect of the instruction based on Van Hiele model on the geometrical thinking levels of preservice elementary school teachers. *Procedia-Social and Behavioral Sciences*, *1*(1), 154-159.

Fabiyi, T. R. (2017). Geometry concepts in mathematics perceived difficult to learn by senior secondary school students in Ekiti State Nigeria. *IOSR Journal of Research & Method in Education (IOS-JRME)*, *7*, 83.

Farkas, R. D. (2003). Effects of traditional versus learning-styles instructional methods on middle school students. *The Journal of Educational Research*, *97*(1), 42-51.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). Sage.

Fitriyani, H., Widodo, S. A., & Hendroanto, A. (2018). Students' Geometric Thinking based on Van Hiele's Theory. *Infinity Journal*, *7*(1), 55-60.

Frasier, B. J. (2010). *Secondary school mathematics teachers' conceptions of proof*. University of Massachusetts Lowell.

Fujita, T., & Jones, K. (2007). Learners' understanding of the definitions and hierarchical classification of quadrilaterals: towards a theoretical framing. *Research in Mathematics Education*, *9*(1), 3-20.

Funkhouser, C. (2003). The effects of computer-augmented geometry instruction on student performance and attitudes. *Journal of Research on Technology in Education*, *35*(2), 163-175.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2009). *Educational research: Competencies for analysis and applications*. Merrill/Pearson.

Ghimire, K. P. (2010). Lower secondary level students' achievement in mathematics in Kathmandu district. *Mathematics Education Forum, 14*(1), 15-20.

Ghosh, S. K. (2016). Impact of In-service Education for Teachers on Curricular Practices at School Level. *Volume V March 2016, 2277*, 136- 145.

Grover, Varun (2000). *A tutorial on Survey Research*: From Construct to Theory. University of South Carolina, Columbia, SC29208. http://www.dmsweb.badm.sc.edu/grover/survey/MISSUVY.html

GuNuc, S. (2014). The relationship between student engagement and their academic achievement. *International Journal on New Trends in Education and Their Implications*, *5*(4), 216-231.

GuNuc, S. (2014). The relationship between student engagement and their academic achievement. *International Journal on New Trends in Education and Their Implications*, *5*(4), 216-231.

Guo, Y., Piasta, S. B., Justice, L. M., & Kaderavek, J. N. (2010). Relations among preschool teachers' self-efficacy, classroom quality, and children's language and literacy gains. *Teaching and Teacher Education*, *26*(4), 1094-1103.

Hallinan, M. T. (2008). Teacher influences on students' attachment to school. *Sociology of education*, *81*(3), 271-283.

Hamre, B. K., Pianta, R. C., Burchinal, M., Field, S., LoCasale-Crouch, J., Downer, J. T., & Scott-Little, C. (2012). A course on effective teacher-child interactions: Effects on teacher beliefs, knowledge, and observed practice. *American Educational Research Journal*, *49*(1), 88-123.

Hanna, G. (2000). A critical examination of three factors in the decline of proof. *Interchange*, *31*(1), 21-33.

Hardianti, D., Priatna, N., & Priatna, B. A. (2017, September). Analysis of Geometric Thinking Students' and Process-Guided Inquiry Learning Model. In *Journal of Physics: Conference Series* (Vol. 895, No. 1, p. 012088).

Henson, K. T. (2004). *Constructivist methods for teaching in diverse middle-level classrooms*. Allyn & Bacon.

Hiebert, J., & Lefevre, P. (1986). Conceptual and procedural knowledge in mathematics: An introductory analysis. *Conceptual and Procedural Knowledge: The case of Mathematics*, *2*, 1-27.

Holubec, E. (2001). *Cooperative learning*. *A Web-based System for the Professional Development of Teachers in Contextual Teaching and Learning Project*. Bowling Green, OH: Bowling Green State University.

Hou, C. S. (2007). *A study on the relationship between teacher-student style match or mismatch and English learning achievements* [Unpublished master's thesis]. National Yunlin University of Science and Technology, Yunlin, Taiwan.

Howes, C., Burchinal, M., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Ready to learn? Children's pre-academic achievement in pre-kindergarten programs. *Early Childhood Research Quarterly*, *23*(1), 27-50.

Howse, T. D., & Howse, M. E. (2014). Linking the Van Hiele theory to instruction. *Teaching Children Mathematics*, *21*(5), 304-313.

Idris, N. (2005). *Teaching and Learning of mathematics*. Utusan Publications.

Ishartono, N., Nurcahyo, A., & Setyono, I. D. (2019, July). Guided discovery: an alternative teaching method to reduce students' rote learning behavior in studying geometric transformation. In *Journal of Physics: Conference Series* (Vol. 1265, No. 1, p. 012019). IOP Publishing.

Jackson, D. N. (1970). A sequential system for personality scale development. In *Current topics in clinical and community psychology* (Vol. 2, pp. 61-96). Elsevier.

Jacob, R., Hill, H., & Corey, D. (2017). The impact of a professional development program on teachers' mathematical knowledge for teaching, instruction, and student achievement. *Journal of Research on Educational Effectiveness*, *10*(2), 379-407.

Jamieson, S. (2004). Likert scales: How to (ab) use them? *Medical education*, *38*(12), 1217-1218.

Jang, E. E., & Roussos, L. (2007). An investigation into the dimensionality of TOEFL using conditional covariance-based nonparametric approach. *Journal of Educational Measurement*, *44*(1), 1-21.

Jonassen, D. H., & Strobel, J. (2006). Modeling for meaningful learning. In *Engaged learning with emerging technologies* (pp. 1-27). Springer.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. *Current Journal of Applied Science and Technology*, 396-403.

Jupri, A. L. (2005). Banyak Cara, Satu Jawaban: Analisis Terhadap Strategi Pemecahan Masalah Geometri. *Aljupri. staf. upi. edu*, 697-703.

Khanal, B. (2018). *Learning strategies of mathematics students* [Doctoral dissertation]. Tribhuvan University.

Khanal, P., & Pheyak, P. (2018). *Performance Audit of Educational Institutions 2017: Overall Report, 2018*. ERO, Government of Nepal.

Kroeker, K. L. (2010). Engineering the web's third decade. *Communications of the ACM*, *53*(3), 16-18.

Kurtulus, A., & Uygan, C. (2010). The effects of Google Sketchup based geometry activities and projects on spatial visualization ability of student mathematics teachers. *Procedia-Social and Behavioral Sciences, 9,* 384-389.

Lewis, J. L., & Sheppard, S. R. (2006). Culture and communication: can landscape visualization improve forest management consultation with indigenous communities? *Landscape and Urban Planning*, *77*(3), 291-313.

Lindquist, M. M., & Clements, D. H. (2001). Geometry must be vital. *Teaching Children Mathematics*, *7*(7), 409-409.

Lubben, F., Campbell, B., & Dlamini, B. (1996). Contextualizing science teaching in Swaziland: some student reactions. *International Journal of Science Education*, *18*(3), 311-320.

Luitel, B. C. (2003). *Narrative explorations of Nepali mathematics curriculum landscapes: An epic journey* [Unpublished Master's dissertation]. Curtin University of Technology, Perth, Australia.

Lunenburg, F. C., &Irby, B. J. (2008). *Writing a successful thesis or dissertation: Tips and strategies for students in the social and behavioral sciences*. Corwin Press.

Mainali, B. R., & Heck, A. (2017). Comparison of traditional instruction on reflection and rotation in a Nepalese high school with an ICT-rich, student-centered, investigative approach. *International Journal of Science and Mathematics Education*, *15*(3), 487-507.

Majerek, D. (2014). Application of Geogebra for teaching mathematics. *Advances in Science and Technology Research Journal*, *8*(24), 51-54.

Manandhar, N. K. (2018). Conceptual and procedural knowledge of students in mathematics: A mixed method study [Unpublished master's dissertation]. Kathmandu University, Dhulikhel, Nepal

Martin, D. B. (2013). Race, racial projects, and mathematics education. *Journal for Research in Mathematics Education*, *44*(1), 316-333.

Marzano, R. J. (2003). *What works in schools: Translating research into action*. ASCD.

Mayer, R. E. (2002). Rote versus meaningful learning. *Theory into practice*, *41*(4), 226-232.

Mayer, R. E., & Wittrock, M. C. (1996). Problem-solving transfer. *Handbook of Educational Psychology*, 47-62.

Metsämuuronen, J., & Kafle, B. R. (2013). *Where are we now? Student achievement in Mathematics, Nepali, and Social Studies in 2011*. Sage.

Meyer, D. K., & Turner, J. C. (2002). Discovering emotion in classroom motivation research. *Educational Psychologist*, *37*(2), 107-114.

Mingus, T. T., & Grassl, R. M. (1999). Preservice teacher beliefs about proofs. *School Science and Mathematics*, *99*(8), 438-444.

Mohrman, S. A., Tenkasi, R. V., & Mohrman Jr, A. M. (2003). The role of networks in fundamental organizational change: A grounded analysis. *The Journal of Applied Behavioral Science*, *39*(3), 301-323.

Mostafa, M., Javad, L. M., & Reza, O. H. (2017). The effect of Van Hiele theory-based teaching educational package on achievement goal orientation of student teachers. *Rev. Eur. Stud.*, *9*, 93.

Muchsin, S. B., Kamaruddin, R., & Rosida, V. (2018, June). Developing Learning Instruments of Geometry Based on Van Hiele Theory to Improving Students'

Character. In *Journal of Physics: Conference Series* (Vol. 1028, No. 1, p. 012137). IOP Publishing.

Muijs, D. (2004). *Doing quantitative research in education* (1st ed.). Sage.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Author.

Navarro Sada, A., & Maldonado, A. (2007). Research Methods in Education. Lawrence Manion and Keith Morrison.

NEB (2019). SEE Result Analysis Report. National examination Board, Sanothemi, Bhaktapur, Nepal.

NEB (2019). *SEE result analysis report*. National examination Board, Sanothimi, Bhaktapur, Nepal.

Nunnally, J. C., & Bernstein, I. H. (1994). Psychological theory.

Nwoke, B. I., & Charles, N. U. (2016). Causes and solutions of mathematics phobia among secondary School Students. *Research on Humanities and Social Sciences*, *6*(20), 105-110.

Okigbo, E.C. (2010). *Comparative effectiveness of mathematical game and instructional analogy as advance organizers on student's achievement and interest in mathematics* [Unpublished Doctoral Dissertation]. Nnamdi Azikwe University, Awka, Nigeria.

Oktaviyanthi, R., & Supriani, Y. (2015). Utilizing Microsoft Mathematics in Teaching and Learning Calculus. *Indonesian Mathematical Society Journal on Mathematics Education*, *6*(1), 63-76.

Olaniyan, M.O. & Salman, M.F. (2015). Causes of mathematics phobia among senior school students: Empirical evidence from Nigeria. *The African Symposium* 15(1), 50-56.

Ozerem, A. (2012). Misconceptions in geometry and suggested solutions for seventh grade students. *International Journal of New Trends in Arts, Sports & Science Education, 1 (4), 23-35*.

Pant, B. P. (2017). Doing, teaching, learning, and thinking about mathematics–On becoming a transformative teacher. *Journal of Education and Research*, *7*(1), 11-24.

Panthi, R. K., & Belbase, S. (2017). Teaching and learning issues in mathematics in the context of Nepal. *European Journal of Educational and Social Sciences*. [Preprint]

Park, K. (2005). Preventive and social medicine. Sage.

Performance Audit report (2016). Educational review Office, Sanothemi, Bhaktapur, Nepal.

Perin, D. (2011). *Facilitating student learning through contextualization*. Community College Research Center.

Perrin, J. R. (2008). Developing reasoning through proof in high school calculus. *The Mathematics Teacher*, *102*(5), 341-349.

Pianta, R. C., Barnett, W. S., Burchinal, M., & Thornburg, K. R. (2009). The effects of preschool education: What we know, how public policy is or is not aligned with the evidence base, and what we need to know. *Psychological Science in the Public Interest*, *10*(2), 49-88.

Protheroe, N., & Clarke, S. (2008). Learning strategies as a key to student success. *Principal*, *88*(2), 33-37.

Quirk, B. (2002). *Understanding the revised NCTM Standards: Arithmetic is still missing!* https://www.wgquirk.com/NCTM2000.html#advice.

Reid, D. (1995). *The need to prove* [Unpublished doctoral dissertation]. University of Alberta, Department of Secondary Education.

Reyes, J., Insorio, A. O., Ingreso, M. L. V., Hilario, F. F., & Gutierrez, C. R. (2019). Conception and Application of Contextualization in Mathematics Education. *International Journal of Educational Studies in Mathematics*, *6*(1), 1-18.

Rittle-Johnson, B., Siegler, R. S., & Alibali, M. W. (2001). Developing conceptual understanding and procedural skill in mathematics: An iterative process. *Journal of Educational Psychology*, *93*(2), 346.

Rubin, H. J., & Rubin, I. S. (2011). *Qualitative interviewing: The art of hearing data*. sage.

Sa'ad, T. U., Adamu, A., & Sadiq, A. M. (2014). The causes of poor performance in mathematics among public senior secondary school students in Azare metropolis of Bauchi State, Nigeria. *Journal of Research & Method in Education*, *4*(6), 32.

Sah, S. P. (2016). *Problems of Teaching and Learning Mathematics in Geometry at Grade-IX* [Doctoral dissertation]. Department of Mathematics Education Central Department of Education University Campus, Kirtipur Tribhuvan University Kathmandu, Nepal.

Saha, R. A., Ayub, A. F. M., & Tarmizi, R. A. (2010). The effects of GeoGebra on mathematics achievement: Enlightening coordinate geometry learning. *Procedia-Social and Behavioral Sciences*, *8*, 686-693.

Sahin, O. (2008). *In -& pre-service elementary school teacher? Van Hiele reasoning stages*. [Master Thesis]. Kocatepe University, Institute of Social Sciences, Afyon.

Santos, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension*, *37*(2), 1-5.

Schank, R. C. (1994). Active learning through multimedia. *IEEE Multimedia*, *1*(1), 69-78.

Sharma, T. (2016). Practices and Possibilities in Nepalese Mathematics Education. *EDiMaST: Experiences of Teaching with Mathematics, Sciences and Technology*, *2*(1).

Sharma, U., Forlin, C., & Loreman, T. (2008). Impact of training on pre-service teachers' attitudes and concerns about inclusive education and sentiments about persons with disabilities. *Disability & Society*, *23*(7), 773-785.

Shrestha, I. M. (2019). Facilitating Culturally De/Contextualised Mathematics Education: An Arts-Based Ethnodrama. In *Research as Transformative Learning for Sustainable Futures* (pp. 225-238). Brill Sense.

Shrestha, M. (2018). *Embodiment of geometry in traditional Newari art. An ethnographic inquiry* [Unpublished master's dissertation]. Kathmandu University.

Singh, K., Junnarkar, M., & Kaur, J. (2016). Norms for test construction. In *Measures of Positive Psychology* (pp. 17-34). Springer.

Smith, T. E. (2019). The impact of training on teachers' family-school engagement practices, attitudes, and knowledge: Exploring conditions of efficacy. *The School Psychologist*, *73*, 21-32.

Solaiman, N. P., Magno, S. N., & Aman, J. P. (2017). Assessment of the Third Year High School Students' Van Hiele Levels of Geometric Conceptual Understanding in Selected Secondary Public Schools in Lanao del Sur. *Journal of Social Sciences (COES & RJ-JSS)*, *6*(3), 603-609.

Spring (2010). *Realia and contextualization*. http://www.gaining.educ.msu.edu/resources/node/422

Stitt-Gohdes, W. L. (2001). Business Education Students' Preferred Learning Styles and Their Teachers' Preferred Instructional Styles: Do They Match? *Delta Pi Epsilon Journal*, *43*(3), 137-51.

Stylianou, D. A., Blanton, M. L., & Knuth, E. J. (Eds.). (2010). *Teaching and learning proof across the grades: A K-16 perspective*. Routledge.

Sunardi, S. (2016). Hubungan antara Tingkat Penalaran Formal dan Tingkat Perkembangan Konsep Geometri Siswa. *Jurnal Ilmu Pendidikan*, *9*(1).

Tan, T. H., Tarmizi, R. A., Yunus, A. S. M., & Ayub, A. F. M. (2015). Understanding the primary school students' van Hiele levels of geometry thinking in learning shapes and spaces: A Q-methodology. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(4), 793-802.

Thagunna, S. S. (2015). *Exploring learning difficulties in school level geometry*. [Unpublished master's dissertation]. Kathmandu University.

Thapa, K. K. (2016). *Geometry anxiety in secondary level in grade nine* [Unpublished Master's research project]. Kathmandu University.

Tillfors, M. (2004). Why do some individuals develop social phobia? A review with emphasis on the neurobiological influences. *Nordic Journal of Psychiatry*, *58*(4), 267-276.

Tutkun, O. (2011). Internet access, use and sharing levels among students during the teaching learning process. *The Turkish Online Journal of Educational Technology, 10*(3)

Ural, A. (2016). Investigating 11th Grade Students' Van-Hiele Level 2Geometrical Thinking. *Journal of humanities and social science, 21*(12), 13-19.

Viglietti, J. M. (2011). *Teachers' definition constructions and drawing productions of basic plane figures: An investigation using the van Hiele theory*. State University of New York at Buffalo.

Vojkuvkova, I. (2012). The van Hiele model of geometric thinking. *WDS'12 Proceedings of Contributed Papers*, *1*, 72-75.

Yee, S. P., & Bostic, J. D. (2014). Developing a contextualization of students' mathematical problem solving. *The Journal of Mathematical Behavior*, *36*, 1-19.

Yin, R. K. (2003). Case study research: Design and methods (Vol. 5). Sage.

Yonck, R. (2010). The age of the interface. *The Futurist*, *44*(3), 14.

Yudianto, E., Sunardi, S. T., Susanto, S., & Trapsilasiwi, D. (2018, March). The identification of van Hiele level students on the topic of space analytic geometry. In *J. Phys. Conf. Ser* (Vol. 983, No. 1, pp. 1-5).

Yudianto, E., Suwarsono, S., & Juniati, D. (2017, April). The anticipation: How to solve problem in integral? In *J. Phys. Conf. Ser* (Vol. 824, No. 1).

Zeeb, M. S. (2004). *Improving student success through matching learning and teaching styles* [Unpublished Master of Arts in Education research project]. University of Phoenix.

Zuya, E. H., & Kwalat, S. K. (2015). Teacher's knowledge of students about geometry. *International Journal of Learning, Teaching and Educational Research*, *13*(3).

APPENDIX

APPENDIX A: PILOTING DRAFT OF QUESTIONNAIRE

Questionnaire for the Students:

Questionnaires Related to Content

S.N	Statements	S.A	A	N	D	S.D
1.	I can understand the terminologies used in geometry theorems.					
2.	I can understand the verbal problems in geometry theorems.					
3.	I can see the theorems are interconnected with one another.					
4.	I feel geometry theorems are more complicated than other content in mathematics.					
5.	I feel comfortable in proving geometry theorems experimentally.					
6	I feel complicated to translate the words into the figure.					

7. I feel easy to prove geometry theorems when figures are given.
8. I feel geometry theorems are less practicable in our real life.
9. I feel easy while proving geometry theorems.
10. I see the less practical implications of geometry theorems in future which less encourage me to learn it.
11. I feel difficult to solve the geometry theorems without the help of teacher.
12. I see the theorems are less connected with the knowledge obtained in previous grade.
13 I feel theoretical learning seems difficult than solving problem in mathematics.
14 The content of geometry theorem is enough to give me conceptual understanding.

Questionnaire Related to Teaching Learning Activities

15. Our classes of geometry begin

in an interesting way.

16. Our teacher participates with us in proving geometry theorems. (By sitting together and providing the necessary support)
17. Our teacher uses ICT while teaching geometry classes that visualized the concepts of theorem.
18. Our teacher provides enough opportunity for all the students in our class.
19. Our teacher provides extra similar problems related with the exercise while teaching theorems.
20. Our teacher less response to all the students in our class.
21. I feel afraid to ask questions with my teacher.
22. Our teacher focuses on group works while proving geometry theorems.
23. I found the materials used by

our teacher while teaching geometry theorems is not clearing my concepts in it.

24. Our teacher focuses more on theoretical proof than practical concepts while proving geometry theorems.

25. The change in teachers in short period of time in our school is creating difficulty in learning Mathematics.

26. Our teacher provides more opportunity for low achieving students while proving theorems in classroom.

27. Our teacher focuses on our curiosity in learning geometry theorems.

28. I feel easy to learn geometry theorems with my friends.

Questionnaires Related to School Administration

29. We have good excess of internet at school to look the supportive materials for geometry theorems.

30. We have facility of math lab at school which supports us in learning geometry theorems.
31. More extra activities (like sports/ arts) in school are affecting in our geometry theorem learning.
32. Our school focus is only to the scores in examination which motivate students in rote memorization of theorems without understanding.
33. The division of section of our class is according to the student's achievements, so low achiever students' class do not get any support in learning theorems.
34. We feel difficulty while participating in the congested classroom.
35. Manipulative geometrical materials are less available in our school.
36. Our school do not reward the

high achieving students in mathematics which less motivate students in learning geometry theorems.

Questionnaires Related to Evaluation Techniques

37. Our teacher checks our homework daily.
38. Our teacher provides regular feedbacks in our work in learning geometry theorems.
39. I feel difficulty in proving geometry theorems in time boundary of examination.
40. Our teacher takes different types of test like class tests, board tests, etc. except terminal examination.
41. Our teacher provides more opportunity for the low achiever in test.
42. Our teacher provides us multiple ways of proving techniques as per our competency area after the class evaluation.

43. Our teacher motivates us in proving geometry theorems if someone achieve less marks in geometry tests.
44. Our teacher focuses more to the scores in examination.
45. 3 hours exam in Mathematics is not enough for me to prove geometry theorems.

If you have experienced any other factors which are responsible in difficulty in learning geometry theorems for you then please mention below.

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Questionnaire for the Teachers:

Questionnaires Related to Content

S.N	Statements	S.A	A	N	D	S.D
1.	My students can understand the terminologies used in geometry theorems easily.					

2. My students can understand the verbal problems in geometry theorems easily.
3. Students feel difficult to find the connection between the theorems.
4. Students feel geometry theorems are more complicated than other content in mathematics.
5. Students feel comfortable in proving geometry theorems experimentally.
6. Students feel complicated to translate the words into the figure.
7. Students feel easy to prove geometry theorems when figures are given.
8. Students' feel geometry theorems are less practicable in their real life.
9. Students feel easy while proving geometry theorems theoretically.
10. Students feel difficult to solve the geometry theorems without the guidance of teacher.
11. I see the theorems are less connected with the knowledge

obtained in previous grades.

12. Theoretical learning seems difficult than solving problem in mathematics.
13. The content of geometry is enough to give conceptual understanding of theorems for students.
14. The examples in the text book are not enough in geometry theorem section.

Questionnaires Related to Teaching Learning Activities

15. The poor foundation of students in primary/ lower secondary school mathematics poses problems in learning geometry theorems.
16. Geometry theorems in secondary mathematics less match with the student's cognitive level.
17. Geometry theorems in mathematics less match with the interest of students.
18. I am using ICT while teaching geometry classes that visualized the concepts of theorems.
19. Students' have psychological fear

of the topic “Geometry theorems” which poses problem in learning it.

20. Because of less practice from students side results in poor performance in geometry theorems.
21. I am able to guide my students in a single class individually.
22. I can easily complete teaching Mathematics course content in mentioned time frame.
23. I think the content of Geometry is more than the student’s ability.
24. I am able to check all the copies of my students after completing each exercise.
25. I am able to provide feedback for all the students individually.
26. I focus more for the high achieving students while teaching geometry theorems.
27. I encourage students to participate in a group while proving geometry theorems.
28. I feel easy to teach geometry theorems.

29. I think the use of appropriate ICTs tools create better understanding among students
30. Most of the student prefer to leave some parts of geometry theorem assuming that does not affect their letter grading in examination

Questionnaire Related to School Administration

31. We have good excess of internet at school to look the supportive materials for teaching geometry theorems.
32. We have facility of math lab at school which supports students in learning geometry theorems.
33. More extra activities (like sports/ arts) in school are affecting in students' geometry theorem learning.
34. Our school focus is only to the scores in examination which motivate students only in rote memorization of theorems.
35. The division of section of our classroom is according to the

student's achievements, so low achiever students' class get less support for learning theorems.

36. Students feel difficulty in enough participating because of large number of students in a single classroom.
37. Manipulative geometrical materials are less available in our school.
38. Our school do not reward the high achieving students in mathematics which less motivate them in learning Mathematics.

Questionnaire Related to Teacher Professional Development

39. I am teaching geometry theorems in the same way how I have learned.
40. I (probably others) am not getting effective training to teach geometry theorems in school.
41. I am less familiar with the ICT tools which can be used to teach geometry theorems.
42. I have less competency in teaching geometry theorems.
43. The trainings I have gained are not

sufficient in teaching geometry theorems.

44. I (probably others) am not update with the new theorem in geometry so, I feel difficult to guide my students in it.

If you have experienced any other factors which are responsible in difficulty in learning geometry theorems for you then please mention below.

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APPENDIX B: FINAL SURVEY TOOL

A Research Study on

"PROBLEMS IN LEARNING GEOMETRY THEOREMS IN SECONDARY SCHOOLS: A MIXED METHOD STUDY"

Dear Students,

Currently, as a student I am pursuing my M. Ed. in Mathematics Education at Kathmandu University School of Education, Hattiban, Lalitpur, and by profession I am a mathematics teacher developing myself as a teacher educator. For the partial fulfillment of my master's study, as a researcher I am conducting a survey research on "Problems in Learning Geometry Theorems in Secondary Schools: A Mixed Method Study" for which I need your support in answering the survey questionnaires.

I assure all of you that this research study is only for the academic purpose and hence there will not be any misuse of any information provided by all of you and no harm on your personal and social life.

As far as I have experienced, 'Geometry Theorems' seem like a difficult section for teaching and learning procedure in school Mathematics. In this regard, the present study aims at identifying the problems which are responsible for creating difficulty in learning Geometry theorems in our context.

With the hope of developing a reliable research tool, I am going to conduct this survey study. In this regard, I humbly request all of you for your voluntary participation in responding to the following questionnaires. There are not any completely right or wrong responses. They are based on your experiences and observations. Please, read the following questionnaires carefully and respond to all the statements honestly as far as possible with tick mark (✔) against each question. I will be very thankful for your participation in this study.

INTRODUCTORY INFORMATION

1. Name

(not

mandatory)

2. Sex

Male …….. Female …… Others …….

3. Grade

IX …..... X…….

The following abbreviation in the table denotes:

S.A = Strongly Agree (पूर्ण रूपमा सहमत) A = Agree (सहमत)

N = Neutral (तटस्थ) D = Disagree (असहमत)

S.D = Strongly Disagree (पूर्ण असहमत)

Note: You can mark in your choosing option.

Questionnaire for the Students:

Questionnaires Related to Content

S. N	Statements	SA	A	N	D	SD
1.	I can understand the terminologies used in geometry theorems. (म ज्यामितिका साध्यहरुमा प्रयोग हुने शब्दावलीहरू राम्रो संग बुझ्छु ।)					
2.	I can see the theorems are interconnected with one					

another.

(म साध्यहरु बिचको

सम्बन्धहरु देख्न सक्छु)

3. I feel geometry theorems are more complicated than other content in mathematics.

(मलाई गणितको अन्य विषय

बस्तु भन्दा ज्यमितिका

साध्यहरु गाह्रो लाग्छ।)

4. I feel comfortable in proving geometry theorems experimentally.

(मलाई ज्यामितिका साध्यहरु

प्रयोगात्मक विधिबाट

प्रमाणित गर्न सजिलो लाग्छ।)

5. I feel complicated to translate the words problems into the figure.

(मलाई शब्दमा दिइएको

साध्य चित्रमा रुपान्तरण गर्न

गाह्रो लाग्छ।)

6. I feel easy to prove geometry theorems when figures are given.
(मलाई ज्यामितिका साध्यहरु चित्रमा दिएको बेला प्रमाणित गर्न सजिलो लाग्छ।)

7. I feel geometry theorems are less practicable in our real life.
(म ज्यामितिका साध्यहरु वास्तविक जीवनमा कम प्रयोग भएको महसुस गर्छु।)

8. I see the less practical application of geometry theorems in future which less encourage me to learn it.
(मेरो दैनिक जीवनमा ज्यामितिका साध्यहरुको प्रयोग एकदमै कम रहेको हुँदा मलाई साध्य सिक्न कम प्रेरणा मिलेको छ।)

9. I find the theorems are less

connected with the knowledge

obtained in previous grade.

(मलाई गणितको साध्यहरु

अघिल्लो कक्षामा पढेको

तथ्यहरुसंग कम मेल

खाएको जस्तो लाग्छ।)

10. I feel theoretical learning

seems difficult than solving

problem in mathematics.

(मलाई प्रयोगात्मक समस्या

समाधान गर्नु भन्दा

सैध्दान्तिक सिकाई गाह्रो

लाग्छ।)

Questionnaire Related to Teaching Learning Activities

11. Our classes of geometry begin

in an interesting way.

(हाम्रो ज्यामितिको कक्षा

रोमाञ्चक (interesting)

ढंगले सुरु हुन्छ।)

12. I feel difficult to solve the

geometry theorems without

the help of teacher.

(मलाई शिक्षकको

सहजीकरण बिना

ज्यामितिका साध्यहरु

प्रमाणित गर्न गाह्रो लाग्छ।)

13. Our teacher uses ICT such as mobile, laptop, desktop-computer, etc. to clarify geometry theorems.

(हाम्रो शिक्षकले ज्यामितिका

साध्यहरु प्रमाणित गर्न

आइसीटी सामाग्रीहरु जस्तै:

मोबाइल, ल्यापटप, कम्प्युटर

आदी प्रयोग गर्नु हुन्छ।)

14. Our teacher provide enough learning opportunity for all the students in our class.

(हाम्रो शिक्षकले सम्पूर्ण

विद्यार्थीलाई प्रयाप्त अवसर

प्रदान गर्नु हुन्छ।)

15. Our teacher provides extra

similar problems related with the exercise while teaching theorems.

(हाम्रो शिक्षकले साध्यहरु सिकाउदा उस्तै किसिमका थप समस्याहरु प्रदान गर्नुहुन्छ।)

16. Our teacher less response to all the students in our class.

(हाम्रो शिक्षकले हाम्रो कक्षाका सबै विद्यार्थीहरुलाई कम प्रतिक्रिया दिनु हुन्छ।)

17. I am afraid of asking questions with my teacher.

(म मेरो शिक्षकसंग प्रश्नहरु सोध्न डराउछु।)

18. Our teacher focuses on group works while proving geometry theorems.

(हाम्रो शिक्षकले ज्यामितिका साध्यहरु प्रमाणित गर्दा समूह

कार्यमा जोड दिनुहुन्छ।)

19. I find that the teaching-learning materials used by my teacher is less effective in clarifying the concepts while proving theorems.
(मेरो शिक्षकले साध्यहरु प्रमाणित गर्दा प्रयोग गर्ने शिक्षण सामग्रीहरु अवधारणा स्पष्ट पार्न कम प्रभावकारी छन् ।)

20. Our teacher focuses more on theoretical proof than experimental verifications while proving geometry theorems.
(हाम्रो शिक्षकले ज्यामितिका साध्यहरु प्रमाणित गर्दा प्रयोगात्मक अवधारणा भन्दा सैध्दान्तिक प्रमाणमा बढी जोड दिनु हुन्छ।)

21. Our teacher provides more opportunity for low achieving students while proving theorems in the classroom.
(हाम्रो शिक्षकले कक्षामा साध्य प्रमाणित गर्दा कमजोर विद्यार्थीहरुको लागि बढी अवसर दिनु हुन्छ।)

22. Our teacher focuses on our curiosity in learning geometry theorems.
(शिक्षकले ज्यामितिका साध्यहरुको सिकाईमा हाम्रो उत्सुकतालाई महत्व दिनु हुन्छ।)

23. I feel easy to learn geometry theorems with my friends.
(म मेरा साथीहरुसँग ज्यामितिका साध्यहरु सिक्न सजिलो महसुस गर्छु।)

Questionnaires Related to School Administration

24. We have good access of internet at our school to find the supportive materials for learning geometry theorems.
(हाम्रो विद्यालयमा ज्यामितिका साध्यहरु सिक्नको लागि सहयोगी सामाग्रीहरु खोज्न उपयुक्त इन्टरनेटको व्यवस्था छ।)

25. We have facility of Math Lab at our school which supports us in learning geometry theorems.
(हाम्रो विद्यालयमा गणित ल्याबको व्यवस्था छ जसले हामीलाई ज्यामितिका साध्यहरु सिक्न मद्धत पुगेको छ।)

26. Because of maximum extra-curricular activities (like sports/ arts) in school, I am not

able to attend the regular class of Mathematics.

(विद्यालयमा अधिकतम अतिरिक्त गतिविधिहरु (जस्तै: खेल, कला) को कारण म गणितको नियमित कक्षामा कम उपस्थित हुन्छु।)

27. Our school education system focus is only to the marks in examination which motivates students in rote memorization of theorems without understanding.

(हाम्रो विद्यालय शिक्षा परीक्षाको प्राप्ताङ्कमा (marks) केन्द्रित रहेकोले मलाई साध्य नबुझिकन कण्ठस्त पार्न प्रेरित गर्छ।)

28. The division of section of our class is according to the

student's achievements, and hence low achiever students get less support in learning theorems.

(हाम्रो कक्षामा विद्यार्थीको प्राप्ताङ्क अनुसार सेक्शन छुट्याइन्छ जसले गर्दा थोरै अंक प्राप्त गर्ने विद्यार्थीलाई साध्य सिकाइमा कम सहयोग मिल्दछ।)

29. We feel difficult to actively participate in the classroom activities because of the maximum number of students.

(हाम्रो कक्षामा धेरै विद्यार्थी भएकाले कक्षाकोठा भित्रका सिकाई क्रियाकलापहरुमा सक्रिय रुपमा सहभागी हुन कठिनाई महसुस हुन्छ।)

30. Manipulative geometrical materials (e.g., Charts, Solid

materials, etc.) are less
available in our school.
(हाम्रो विद्यालयमा
ज्यामितीलाइ बुझाउन अन्य
बस्तुहरु (जस्तै:;;;; चार्ट, ठोस
बस्तुहरु) कम उपलब्ध छन्।)

31. Students are less motivated in learning geometry theorems as our school does not reward the high achiever in mathematics.
(हाम्रो विद्यालयले गणितमा
उच्च अङ्क ल्याउने
विद्यार्थीलाई पुरस्कृत नगर्दा
ज्यामितिका साध्यहरु सिक्न
कम प्रेरणा मिलेको छ।)

Questionnaires Related to Evaluation Techniques

32. Our teacher checks our homework daily.
(हाम्रो शिक्षकले हाम्रो
गृहकार्य दैनिक हेर्नुहुन्छ।)

33. Our teacher provides regular

feedback of our works related to learning geometry theorems.

(हाम्रो शिक्षकले ज्यामितीय साध्य सम्बन्धि कार्यहरुमा निरन्तर पृष्ठपोषण (feedback) दिनु हुन्छ।)

34. I feel difficulty in proving geometry theorems within the given time in the examination.

(मलाई परिक्षामा दिइएको समय भित्र ज्यामितिका साध्यहरु प्रमाणित गर्न कठिनाई हुन्छ।)

35. Our teacher takes different types of test such as unit test, class tests, board tests, etc. except terminal examination.

(हाम्रो शिक्षकले टर्मिनल परिक्षा बाहेक विभिन्न प्रकारका परिक्षाहरु जस्तै

एकाइ परिक्षा, कक्षा परिक्षा,

बोर्ड परिक्षा लिनु हुन्छ।)

36. Our teacher provides us multiple ways of proving theorems as per our competency area after the class evaluation.

(हाम्रो शिक्षकले कक्षा

मुल्यांकन पछि हाम्रो क्षमता

अनुसार साध्य प्रमाणित गर्ने

धेरै तरिका प्रदान गर्नुहुन्छ।)

37. While proving geometry theorems, our teacher helps the low achiever students.

(हाम्रो शिक्षकले ज्यामितीय

साध्य प्रमाणित गर्दा थोरै

अंक (marks) प्राप्त गर्नेलाई

सहयोग गर्नुहुन्छ।)

38. Our teacher focuses more on marks in the examination.

(हाम्रो शिक्षकले परीक्षाको

प्राप्ताङ्कलाइ बढी महत्व दिनु

हुन्छ।)

39. The three hours' exam in
Mathematics is not sufficient
for me to prove geometry
theorems on time.

(तीन घण्टाको परिक्षा मेरा

लागि समयमै ज्यामितिका

साध्यहरु प्रमाणित गर्न

प्रयाप्त छैन।)

If you think that there are some more factors (other than mentioned above), which demotivate (unhelp) you in learning geometry theorems conceptually, then please mention them below;

(यदि तपाईंले ज्यामितिय साध्यहरू सिक्न र सिकाउन असहज महसुस हुने अन्य कुनै प्रकारका कारणहरू अनुभव गर्नुभएको छ भने कृपया तल उल्लेख गर्नुहोस् (प्राथमिकताका आधारमा) ;

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…… Thank You for Your Participation ……

A Research Study on

"PROBLEMS IN LEARNING GEOMETRY THEOREMS IN SECONDARY SCHOOLS: A MIXED METHOD STUDY"

Dear Teachers,

Currently, as a student I am pursuing my master's in mathematics education at Kathmandu University School of Education, Hattiban, Lalitpur, and by profession I am a mathematics teacher developing myself as a teacher educator. For the partial fulfillment of my master's study, as a researcher I am conducting a survey research on "Problems in Learning Geometry Theorems in Secondary Schools: A Mixed Method Study" for which I need your support in answering the survey questionnaires.

I assure all of you that this research study is only for the academic purpose and hence there will be no misuse of any information provided by all of you and no harm on your personal and professional life.

As far as I have experienced, 'Geometry Theorems' seem like a difficult section for teaching and learning procedure in school Mathematics. In this regard, the present study aims at identifying the problems which are responsible for creating difficulty in learning Geometry theorems in our context.

With the hope of developing a reliable research tool, I am going to conduct this survey study. In this regard, I humbly request all of you for your voluntary

participation in responding to the following questionnaires. There are no any completely right or wrong responses. They are based on your experiences and observations. Please, read the following questionnaires carefully and respond to all the statements honestly as far as possible with tick mark (✔) against each question. I will be very thankful for your participation in this study.

INTRODUCTORY INFORMATION		
1.	Name (not mandatory)	
2.	Sex	Male …….. Female …… Others …….
3.	Teaching Experience	……..... years

The following abbreviation in the table denotes:

S.A = Strongly Agree (पूर्ण रूपमा सहमत) A = Agree (सहमत)

N = Neutral (तटस्थ) D = Disagree (असहमत)

S.D = Strongly Disagree (पूर्ण असहमत)

Note: You can mark in your choosing option.

(तपाईंको छनौट विकल्पमा गर्न सक्नुहुन्छ।)

Questionnaire for the Teachers:

Questionnaires Related to Content

S.N	Statements	S.A	A	N	D	S.D
1.	My students can understand the terminologies used in					

geometry theorems.

(मेरा विद्यार्थीहरूले

ज्यामितिका साध्यहरूमा प्रयोग

हुने शव्दहरू बुझ्न सक्दछन्।)

2. Students feel difficult to find the connection between the theorems.

(मेरा विद्यार्थीहरुलाई ज्यामितिय

साध्यहरू बीच सम्बन्ध स्थापित

गर्न गाह्रो लाग्छ।)

3. Students feel that geometry theorems are more complicated than other content in mathematics.

(विद्यार्थीहरूले ज्यामितिय

साध्यहरू गणितको अन्य

विषयवस्तु भन्दा बढी जटिल

महसुस गर्दछन्।)

4. Students feel comfortable in proving geometry theorems experimentally.

(विद्यार्थीहरू ज्यामितिका

साध्यहरू प्रयोगात्मक

बिधिबाट प्रमाणित गर्न सहज
महसुस गर्दछन्।)

5. Students feel complicated to translate the words problems into the figure.
(विद्यार्थीहरू शाब्दिक समस्यालाई चित्रमा अनुवाद गर्न गाह्रो महसुस गर्दछन्।)

6. Students feel easy to prove geometry theorems when figures are given.
(विद्यार्थीहरूले चित्र दिईएको अवस्थामा मात्र ज्यामितिका साध्यहरू प्रमाणित गर्न सजिलो महसुस गर्दछन्।

7. Students' feel that geometry theorems are less practicable in their real life.
(विद्यार्थीहरूले ज्यामितिका साध्यहरू उनीहरूको वास्तविक जीवनमा कम मात्रामा प्रयोग हुन्छ भन्ने ठान्दछन्।)

8. Students feel easy while proving geometry theorems theoretically.
(विद्यार्थीहरूले ज्यामितिका साध्यहरू सैद्धान्तिक रूपमा प्रमाणित गर्दा सजिलो महसुस गर्दछन्।)

9. I find the theorems are less connected with the knowledge obtained in previous grades.
(मैले साध्यहरूलाई अघिल्लो कक्षामा प्राप्त गरेको ज्ञान सँग कम जोडिएको पाएको छु।)

Questionnaires Related to Teaching Learning Activities

10. The poor foundation of students in basic level mathematics poses problems in learning geometry theorems.
(आधारभुत तहमा विद्यार्थीहरूको गणितमा भएको कमजोर आधारले ज्यामितिका

साध्यहरू सिक्नमा समस्या
उत्पन्न गर्दछ।)

11. Students feel difficult to solve the geometry theorems without the guidance of teacher.
(विद्यार्थीहरूले शिक्षकको सहजिकरण बिना ज्यामितिका साध्यहरू समाधान गर्न गाह्रो महसुस गर्दछन्।)

12. Geometry theorems in mathematics less match with the interest of students.
(गणितमा ज्यामितिका साध्यहरू विद्यार्थीको रुचिसँग कम मेल खान्छन्।)

13. I use ICT tools in teaching geometry theorems.
(म गणितका साध्यहरूलाई ICT प्रयोग गरेर पढाउछु ।)

14. Students' have psychological fear of the topic "Geometry theorems".

(विद्यार्थीहरूमा **ज्यामितिय साध्यहरुको** मनोवैज्ञानिक डर छ।)

15. Because of students less practice results in poor performance in learning geometry theorems.
(ज्यामितीय साध्यहरूको सिकाइमा कमजोर प्रस्तुतीको कारण विद्यार्थीहरूको कम अभ्यास हो ।)

16. I can easily complete teaching Geometry content in the mentioned time.
(म ज्यामितीका विषयवस्तुहरू पढाउदा निर्धारित समय भित्र सक्छु ।)

17. I think the content of Geometry is more than the student's ability.
(मलाई लाग्छ ज्यामितीयको विषयवस्तुहरू विद्यार्थीको क्षमता भन्दा बढी छ।)

18. I am able to check all the homework copies of my students after completing each exercise.
(म हरेक एकाइ पूरा गरे पछि मेरा सबै विद्यार्थीहरूको गृहकार्य जाँच गर्न सक्छु।)

19. I am able to provide feedback for all the students individually.
(म सबै विद्यार्थीहरूको लागि व्यक्तिगत रूपमा पृष्टपोषण (feedback) प्रदान गर्न सक्षम छु।)

20. I focus more for the high achieving students while teaching geometry theorems.
(म ज्यामितीय साध्यहरू सिकाउँदा उच्च अंक प्राप्त गर्ने विद्यार्थीहरूलाई बढि केन्द्रित गर्दछु।)

21. I encourage students to participate in a group

discussion while proving geometry theorems.
(म विद्यार्थीहरूलाई ज्यामितीका साध्यहरू प्रमाणित गर्दा समूहगत छलफलमा भाग लिन प्रोत्साहान गर्दछु।)

22. I feel easy to teach geometry theorems.
(म ज्यामिति साध्यहरू सिकाउन सजिलो महशुस गर्दछु ।)

23. I think the use of appropriate ICT tools helps students learn the concepts of geometry theorems.
(मेरो विचारमा उपयुक्त ICT उपकरणहरुको प्रयोगले विद्यार्थीलाइ ज्यामितिय साध्यहरुको अवधारणा सिक्न सहयोग गर्छ ।)

24. Most of the student prefer to leave some parts of geometry assuming that does

not affect their letter grading
in examination.
(धेरैजसो विद्यार्थीहरूले
ज्यामितिको केही अंशहरू
छोड्दा उनीहरूको ग्रेडिंगलाई
असर गर्दैन भन्ने बुझाइ छ।)

Questionnaire Related to School Administration

25. I use internet to search the
supportive materials for
teaching geometry theorems.
(ज्यामितिका साध्यहरू
सिकाउनका लागि सहयोगी
सामग्रीहरू खोज्न म इन्टरनेट
प्रयोग गर्छु।)

26. I use math lab to supports
students in learning
geometry theorems.
(विद्यार्थीहरुको ज्यामिती
सिकाइलाई सहज बनाउन म
गणित प्रयोगशालाको प्रयोग
गर्छु ।)

27. Our school education system
mainly focuses to the scores

in examination that motivate students for rote memorization of theorems.
(हाम्रो विद्यालय शिक्षा प्रणाली परिक्षामा प्राप्त हुने अंकमा केन्द्रित हुने हुनाले विद्यार्थीहरू केवल साध्य कण्ठ गर्न मात्र प्रेरित हुन्छन्।)

28. Students do not get opportunity of sufficient discussion because of large number of students in the classroom.
(कक्षाकोठामा धेरै विद्यार्थी संख्या भएको कारणले गर्दा विद्यार्थीहरूले पर्याप्त छलफलमा भाग लिने अवसर पाउदैनन् ।)

29. Manipulative geometrical materials are less available in our school.
(हाम्रो स्कूलमा ज्यामिती शिक्षणमा प्रयोग हुने सामग्रीहरू

कम उपलब्ध छन्।)

30. Students are less motivated as our school does not reward the high achiever in mathematics.

(हाम्रो विद्यालयले गणितमा उच्च अङ्क ल्याउने विद्यार्थीलाई पुरस्कृत नगर्दा ज्यामितिका साध्यहरु सिक्न उनिहरुलाई कम प्रेरणा मिलेको छ।)

Questionnaire Related to Teacher Professional Development

31. I am teaching geometry theorems in the same way as I have learned.

(म आफुले जसरी ज्यामितिका साध्यहरू सिकेको थिएँ त्यसरी नै मेरा विद्यार्थीहरुलाई सिकाइरहेको छु।)

32. I have not got effective training to teach geometry theorems.

(मैले ज्यामितिका साध्यहरू
सिकाउन प्रभावकारी तालिम
प्राप्त गरेको छैनन्।)

33. I am less familiar with the ICT tools which can be used to teach geometry theorems.
(म ज्यामितिका साध्यहरू
सिकाउन प्रयोग हुने ICT
उपकरणहरूसँग कम परिचित
छु ।)

34. I feel more comfortable in teaching other area of mathematics than geometry theorems.
(मलाइ गणित शिक्षणमा
ज्यामितिका साध्यहरू भन्दा
अन्य विषयवस्तु सिकाउन
सहज लाग्छ।)

35. The trainings I have gained are not sufficient in teaching geometry theorems.
(मैले हासिल गरेका तालिमहरू
ज्यामितिका साध्यहरू

सिकाउन पर्याप्त छैनन्।)

36. I am not updated with the recent ideas in geometry so, I feel difficult to guide my students in it.

(म ज्यामितिका नविनतम ज्ञानका बारेमा अपडेट नभएकाले मलाई आफ्ना विद्यार्थीहरूलाई यसमा शहजिकरण गर्न गाह्रो लाग्छ।)

If you have experienced any other factors which are responsible for creating difficulty in learning geometry theorems, then please mention below (based on priority).

(यदि तपाईंले ज्यामितिय साध्यहरू सिक्न र सिकाउन असहज महसुस हुने अन्य कुनै प्रकारका कारणहरू अनुभव गर्नुभएको छ भने कृपया तल उल्लेख गर्नुहोस् (प्राथमिकताका आधारमा) ;

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…… Thank You for Your Participation ……

APPENDIX C

Name of community high schools with number of Grade IX and X students

Tokha Municipality

S.N	Name of School	No. of Students		
		IX	X	Total
1	Boudeshwor Ma. Vi.	37	30	67
2	Jhormahankal Ma. Vi.	5	10	15
3	Sarashowati Ma. Vi.	67	62	129
4	Dhapasi Ma. Vi.	28	23	51
5	Tilingatar Ma. Vi.	172	158	330
6	Jalupa Ma. Vi.	65	50	115
7	Manohar Ma. Vi.	110	78	188
	Total	484	411	895