Chapter-I

Introduction

Background of the Study

Geometry is the branch of mathematics related to the shape, size, position of figures, and the properties of the space. Geometry arose independently in a number of early cultures as a practical way for dealing with lengths, areas, and volumes. By the 3rd century BC, geometry was put into an axiomatic form by Euclid. While geometry has evolved significantly throughout the years, there are some general concepts that are more or less fundamental to geometry. These include the concepts of points, lines, planes, surfaces, angles, and corves, as well as the more advanced notions of manifolds and topology and metric. Euclid geometry plays the vital role in teaching geometry. The study of points, lines, planes, angles, triangles, congruence, similarity, solid figures, circle, and analytic geometry include in school geometry which is similar to Euclid geometry.

Geometry teaching plays vital role in mathematics teaching. Not only geometric contents but there are also geometric interpretation in algebra and arithmetic which is carried out for understanding. Many learning theories developed in teaching mathematics which helps to learn geometry. Bruner's theory, Piaget's theory, Dienes theory, Gagne's theory, Ausubel's theory are main theories in teaching mathematics. Among these approaches of teaching mathematics, the van Hiele approach of teaching geometry is new method and more effective to teach geometry in the classroom. This approach is most important which has been found useful in assessing students thinking in geometry. Van Hiele level of understanding geometrical ideas and the theory of instruction can be an alternative pedagogy for teaching geometry (Joshi, 2017). Most of the educational researches are continuously

suggesting using van Hiele approach in teaching geometry. The new learning concepts like assessing student's performance using van Hiele approach in teaching geometry at secondary level. Van Hiele developed on the basis of thinking level of students to teach geometry. So, this approach is more effective in teaching geometry at secondary level.

The van Hiele theory has been applied to many curricular to improve geometry classroom instruction in many developed countries such as UK and the USA (Clements, 2004). But in Nepal such type of theory has not been applied to improve the curricula of geometry. There is dearth of literature in the libraries of Nepal related to van Hiele theory. This study, therefore, in the first of its kind to assess the students van Hiele level and impact of these levels on the student's achievements in geometry in Nepalese context. Experiences of the secondary level mathematics teacher indicate that many students encounter difficulties in secondary school geometry in doing proof. Van Hiele belive that the student's difficulty with mathematics generally and geometry in particular is caused largely by teacher’s failure to deliver instruction that is appropriate in their thinking level.

The problem regarding the teaching and learning of geometry was identified in the 1905s by two Dutch mathematicians Pierre van Hiele and his wife, Diana Hiele-Geldof, who due to their frustrations investigated possible reasons that could have created this problem in their classrooms. The findings of their investigations resulted in the development of a theory. The theory distinguishes five different tough levels that a student goes through when learning geometry. The van Hiele theory of geometric thought describes the different levels of understandings through which students' progress when learning geometry (van Hiele 1984). The basis of the theory is the idea that a student’s growth in geometry takes place in terms of distinguishable

levels of thinking. The van Hiele asserted that students must develop masterfully at each level before they are able to progress to the next. "These levels are sequential, invariant and hierarchical" (elements 2003, p. 152). This research work was focused on levels of thinking in geometry and the role of instructions in helping students move from one level to next. (Fuys et. Al. p. 4). Dina van Hiele-Geldof's work deals with a didactic experiment aimed at raising a student's thought level.

In the new area of research, the secondary level is vital level of geometry. So, in this level student's geometry should be meaningful learning of mathematics. But in this area of educational researches in the decades shows that the achievement of geometry is very poor. This attitude towards the geometry due to lack of appropriate teaching method. Nepali government invest more in teaching mathematics and teaching geometry, in spite of efforts significance achievement is not found. These are the many problems and issues of geometry teaching and improve an achievement of students. Is van Hiele approach of teaching geometry at secondary level to teach geometry for improving achievement? What is the students understanding of geometry? How can easily understanding geometry teaching? How can improve the achievement of students in geometry? Researcher tried to find out answers of these questions. Also the researcher tried to find out can van Hiele approach be effect to teach geometry at secondary level.

Statement of the Problems

Geometry is considered an important component of school mathematics. There is an important role of teachers to show all importance of geometry to the students in their teaching. Moreover, geometry has covered 30% area in mathematics curriculum (NCF, 2063). Researcher is teaching mathematics up to now from few years ago, He has experience in teaching geometry. So, researcher feel that majority of students

cannot solve geometric problems as well as other fields of mathematics problems. Students cannot understand geometry as others fields of mathematics, so every class of geometry difficult to understanding for students. Students have low achievement in geometry in every examination because they are not clear in learning in geometry. In SEE exam, geometric problems in 24 marks but more students not interest to learn geometry and they prepare examination without geometry. Many students have low achievement marks in mathematics because they left the question of geometry

In the issues ineffectiveness of conventional/traditional approach of geometry teaching claiming of suitability of van Hiele developmental approach in teaching strategies. The researcher intended to study the effectiveness of van Hiele approach in teaching geometry at secondary level (Grade ten students). This study was an experimental study. The only one parameter of effectiveness used in this study is the learning achievement of the student intended to answer the following question.

- Do the students feel easy in learning geometry using van Hiele approach?
- What is the level of students in geometry according to van Hiele?
- Is van Hiele approach more effective in classroom than conventional approach in teaching geometry at secondary level?

Objectives of the Study

The objectives of the study are

- To find the level of grade X students according tovan Hiele level of geometric thought.
- To explore the effectiveness of van Hiele model of geometric teaching.

Hypothesis of the study

This study would attempt to seek the result of following hypothesis

Research Hypothesis.

The research hypothesis formulated for the research where as follows: There is no significance difference in achievements in geometry teaching at secondary level through the van Hiele approach and conventional approach.

Statistical Hypothesis.

H_o: $\mu_1 = \mu_2$(null hypothesis)

H_1: $\mu_1 \neq \mu_2$ (alternative hypothesis)

where μ_1 is mean score of students of experimental group taught by employing van Hiele approach and μ_2 is mean score of students of control group taught by conventional approach

Significance of the study

Van Hiele model proposes learning phases that are able to help in assisting students to move from one of the van Hiele's level of geometric thinking to a higher level. These learning phases can assist students in learning geometry and with assistance from teachers. They able to discuss certain concepts and develop a more technical use of language. The approach used in these five phases provides a structured lesson. The van Hiele theory stands out as the best recognized framework for the teaching and learning of geometry (Mateya, 2008, p. 36). As a result, this model is often considered as the foundation for curricula implement in mathematics classrooms in many countries, such as Netherlands, Germany, Russia and USA. This study, therefore, in the first of its kind to assess the students van Hiele levels are impact of these levels on the student's achievement in geometry in Nepali context. So this study sought to find the effectiveness of van Hiele levels of thought in teaching geometry.

In brief, the study has the following significances:

- This study experimentally verified and justified the effectiveness of van Hiele approach in geometry teaching. So, teacher can use research following the strategies as used in experimental phase. Research may provide one or more instance to establish a new method of teaching in the Nepalese context.
- The result of the study has given the VH level of the grade 10 students. So, this could be great information to curriculum designers and even the text book writer, so that they could organize and sequence geometric contents according to the students' VH level. This study may provide information to reform and improve geometric learning simple to complex, example to definitions and experiment to theoretical.
- The study experimentally verified a new knowledge that the effectiveness of van Hiele approaches in teaching geometry and level of students according to VH level so this study helps to policy maker of mathematics education at geometry as a new and different knowledge.
- Level wise performance of students according to VH level at geometry also helps to provide information to the concern agencies to reform and improve in providing theorems of geometry.
- Also, the result of the study has given that the teacher using lecture and memorization as the main methods of instruction would not lead to effective learning. Teachers should provide their students with appropriate experiences and the opportunities to discuss them.
- In this study, activities at the intermediate levels have given to help students develop their understanding of figures and properties. Throughout the book, fundamental experiences and opportunities for discussion and reflection help develop successive levels of understanding.

Delimitation of the Study

Any study could not overcome on the errors. This study was not an exception. So this study also has some delimitation which are listed as follows:

- This study is limited around 50 students of Syangja. Therefore, it may be hazardous to generalize the finding of this study in other districts.
- This study is based on van Hieles levels of geometric thinking of secondary school students.
- This study is considered only with the students of grade X of government schools.
- Students' scored in achievements test are not obtained from standardized test.
- Participating students are assigned different van Hiele level only by using paper-pencil test namely VHGT.
- This study mainly confided the two schools of Galyan municipality of Syangja.

Definition of Terms

In this research, achievement, level of thinking, VH level, VHGT, effectiveness, conventional approach, experimental and control group, variables have been used. These words described and explained under these headings.

Achievement. The word achievement in this study is defined as the magnitude of score obtained by the students included in the students included in the school mathematics test.

Levels of thinking. These levels of thinking for this study are as defined by van Hiele. There is the proficiency of skills of the students be attained in the stated matters of concern in levels 0-4 as recognition, analysis, informal deduction, deduction and rigor.

Van Hiele levels. According to van Hiele, all human being progresses through five levels named as visual, analysis, informal deduction, deduction and rigor.

According to this theory students' progress through five levels of sequence in a particular and that students can't reach a higher level without passing through lower level.

Van Hiele Geometric Test (VHGT). VHGT is the analysis of the cognitive development and achievement in secondary school geometry (CDASSG) test, which was used by van Hiele for the students to find their levels. This VHGT consists of different multiple choice question in the order with level 0-4.

Effectiveness. The effectiveness in this study is defined in terms of the magnitude of the score obtained by experimental and control groups in the mathematics achievements test.

Conventional approach. Conventional approach is a teaching method of geometry teaching which teachers flows traditionally as a teacher center method.

Experimental group. Group of students who were taught by van-Hiele approach was considered as experimental group.

Control group. Group of students who were taught by conventional approach was considered as control group.

Variable. A variable is an important concept to study in research methodology. It plays a significance role in measuring the change attributed in research study. It deals with two types of variable such as dependent and independent.

Dependent variable. It is a variable which the researcher observes and measure to determine the effect of independent variable. Achievement score in the VHGT of mathematics is the dependent variable of the study.

Independent variable. Independent variable is major variable which the researcher hopes to investigate. Method of teaching according to van Hiele approach is the independent variable of the study.

Chapter II

Review of the Related Literature

Review of literature is an essential part of all studies. It is the way to discover what other research in the area of one's problem has uncovered. A critical review of the literature helps the researcher to develop the understanding and insight in to previous research works that relates to the present study. The main propose of review of related literature is to develop some expertise in one's area to see what new contributions can be made and receive some idea from developing research design.

Empirical literatures

In this study, three terms are focused: student's achievement, effectiveness of van Hiele (VH) approach, and students' level of geometry according to VH level. These three aspects are briefly reviewed and captured based on literature concern. The researcher tried to find out literature on the topic that related to problems faced by mathematics students in learning geometry, number of books, paper, research reports and book list was found that concern with curriculum, instructional materials, and method and so on. Some of the literatures reviewed by researcher which are related to the present study are discussed below:

A study carried out Joshi, (2017) entitled “Effectiveness of Van Hiele approach in teaching geometry” to compare the Van Hiele approach and traditional approach of teaching geometry and find the attitude of the van Hiele approach of teaching geometry at grade-VII students using experimental study design. In this study, researcher selected the sample consisting of sixty students purposively from public school. The researcher taught the experimental group by using van Hiele approach and the control group by traditional method. The achievement of student is analyzed statistical by using Mean, Stander deviation, variance, CV, t-test at 0.01

level of significance. Thus, the researcher concluded that the van Hiele approach is suitable teaching method in geometry because it is easily understanding, to give the idea of problems solving, interesting the classroom activities in geometry teaching.

A study carried out by Oli, (2014) entitled “Van Hiele levels of Geometric Thought and mathematics achievement of students in Rukum district” with the objective: to analyze the relationship between the VHGT and mathematics achievement at secondary level students using survey study design. He selected 150 students by stratified random sampling method from all 52 secondary schools consisted of all students of grade X in 2069/070 B.S. The achievement students are analyzed statistically by using Mean and Karl person's coefficient of correlation. In this study he found that there is a high relationship between performance in mathematics (VHGT and SMT) and Van Hiele levels for the majority of the students.

Abudllah and Zakaria, (2013) studied on “Enhancing students level of Geometric Thinking Through Van Hiele’s phase based learning.” They developed this research used by Quasi-experimental design. The six-week study was conducted in a secondary school involving 94 students and two teachers. The aim of this study was to identify the effectiveness of Van Hiele’s phase of learning geometry in the learning to further determine the initial level of geometric thinking of the control group. Qualitative data were analyzed. It can be summarized that almost all the students, attained a high acquisition for second level. One student showed a high acquisition for second level. However, none of the students in the control group scored on the third level. It was found that the students in the treatment group showed a better increment of geometric thinking levels compared to students in the control group.

A study carried out by Acharya, (2011) entitled "A study on van Hiele level of thinking of primary school students in geometry" to analyze the thinking level of

geometry students at primary level and also analysis perform in this level boys and girls student. The data were collected from Baglung district all grade-v students and taking sample 260 students using survey design of thinking level in geometry. Tools were test question develop the van Hiele level of thinking geometry and analysis mathematics tools t-test 0.5 level of significance. The obtain information were about 82%, 35%, 59% student had attained the basic skills of geometry of level 0, 1, 2 respectively., and the boys can perform better than the girls in geometry. This study shows that the majority of the students of primary level are in level 2 according to Van Hiele level of geometric thinking. In this study, researcher concluded that the van Hiele level of thinking help the students to understand geometric ideas and also help to motivate and apply the known geometrical concepts in unfamiliar condition.

A study carried out by Gyawali, (2009) entitled "Effectiveness of van Hiele approach in teaching geometry at the secondary level" to analyze the effectiveness of Van Hiele approach in teaching geometry at secondary level student. The data were collected from Nawalparasi district by using experimental research design. In this study researcher selected the sample consisting of forty students purposively from public schools. The researcher taught the experimental group by using Van Hiele approach and the control group by conventional approach. An achievement test was main tool of the study. The achievement of students was analyzed statistical by using mean, standard deviation, t-test at 0.05 level of significance. The researcher concluded that the Van Hiele approach is effective in teaching geometry at secondary level students than conventional approach.

A study carried out Lamsal, (2005) entitled "A study on the effectiveness of van Hiele approach in teaching geometry at lower secondary level" to analyze and explore the effectiveness of van Hiele approach in teaching geometry at lower

secondary level student using experimental study design. Population of his study was grade eight students enrolled in the public school in Syangja district. He conducted this study as experimental on the forty-nine pupils of the sample with the help of teaching episodes as a research tool using by achievement test. The achievement students are analyzed statistical by using mean, standard deviation, t-test at 0.05 level of significance. In this study, the researcher concludes that van Hiele approach is more effective in teaching geometry at grade eight students than conventional approach. This study supported that the van Hiele approach in teaching geometry is more applicable, effectiveness and supporting to improve the achievement of students in geometry.

Pusey (2003) carried out the thesis entitled "The model of reasoning in geometry". The objective of his study were to describe the van Hiele model in more details present research related to model, synthesize the result of such studies, compare the model to other theoretical models and discuss classroom implication. His research highlighted four different areas with respect to models, they are appropriate way to assess student's level of geometric reasoning and result of those assessments, assessments of pre-service and in-service teacher level of reasoning, instructional intervention used with students based on van Hiele model, and intervention with both pre-service and in-service teachers to promote awareness of the theory and improved knowledge of geometric contents. He found in his study that there were three broad categories of research done in van Hiele models. The first core avenue of research has focused on testing the van Hiele theory itself and assumption. A second avenue of research of research has to find appropriate ways to assess the level and discuss implications of these assessments. A third avenue of research with van Hiele theory has looked at the effect of intervention with students and teachers based on the model,

with students the research has thought to determine if instruction based on van Hiele's recommendation is effective in fostering improved reasoning.

Sharma, (1997) did his thesis for master's degree on "A study of understanding of geometric ideas by grade-viii students of Gorkha district" with the objective to find out the distribution of the students with their acquired basic skills of geometry among the boys and girls of grade VIII. He concluded that the level of mental development in understanding geometric ideas advanced the percentage of students decreased with a sudden break in levels III, in level III the trend of students was interrupted by the other levels.

From the literature reviewed, these all support my study effectiveness of van Hiele. The total eight reviews in this study these three reviews related to effectiveness of van Hiele approach, one is about finding relationship between mathematics achievement and VH teaching approach and another four reviews are related student's achievement in geometry. And only two reviews are related to van Hiele phase base learning which are developed by foreign researchers.

Theoretical Literature Review of Study

A husband-and-wife team of Dutch education, Pierre van Hiele and Dina van Hiele Geldof, noticed the difficulties that their students had in learning geometry. These observations led them to develop a theory involving levels of thinking in geometry that students pass through as they progress from merely recognizing a figure to being able to write a formal geometric proof. Their theory explains why many students encounter difficulties in their geometry course, especially with formal proofs. Van Hiele believed that writing proofs requires thinking at a comparatively high level, and that many students need to have more experiences in thinking at lower levels before learning formal geometric concepts.

According to the van Hiele's the student passes through five hierarchical levels of thinking. Originally the van Hiele's numbered the levels basic or 0 and 1 to 4. Wirszup (1976) kept the five levels but renumbered the levels so that Level became Level 1, Level 1 became Level 2 etc. The names used for the levels were first used by Hoffer (1979) as the van Hieles did not name the levels. In 1986 Pierre van Hiele started to use the 1 to 5 scale and consequently most researchers today use the same scale. As van Hiele was a teacher of mathematics he used examples from geometry to illustrate his levels though he did not restrict his theory to Mathematics. The van Hiele theory of geometric thought describe the different level of understanding through which student's progress when learning geometry describe as following:

Level 0: Visualizing. The student operates on geometric figures, such as triangles, and parallel lines by identifying, naming and comparing them according to their appearance. Perception is visual only. A student who is reasoning at level 1 recognizes certain shapes holistically without paying attention to their component parts. For example, a rectangle may be recognized because it looks “like a door” and not because it has four straight sides and four right angles as there is no appreciation of these properties. Shape is important and figures can be identified by name.

Level 1: Analysis. The student discovers properties/rules of a class of shapes empirically, such as folding, measuring, analyzing figures in terms of their components and relationships among components. At this level component parts and their attributes are used to describe and characterize figures. For example, a student who is reasoning analytically would say that a square has four “equal” sides and four “square” corners. The same student, however, might not believe that a figure can belong to several general classes and have several names, e.g. the student may not accept that a rectangle is a parallelogram. A figure at this level presents as a totality of

its properties. A Student may be able to state a definition but will not have understanding.

Level 2: Informal Deduction. By following or giving informal arguments the student logically inter-relates previously discovered properties or rules. The student operates with these relationships both within a figure and between related figures. There are two general types of thinking at this level. Firstly, a student understands abstract relationships among figures, e.g. the relationship between a rectangle and parallelogram and secondly a student can use deduction to justify observations made at level 2. The role of the definition and the ability to construct formal proofs are not understood at this level though there is a comprehension of the essence of geometry.

Level 3: Deduction. The student proves theorems deductively and established interrelationship among networks of theorems. The student can manipulate the relationships developed at level 3. The need to justify relationships is understood and sufficient definitions can be developed. Reasoning at this level includes the study of geometry as a formal mathematical system rather than a collection of shapes.

Level 4: Rigor. The student establishes theorems in different postulations systems and analyses and compares these systems. The study of geometry at level 5 is highly abstract and does not necessarily involve concrete or pictorial models. At this level the postulates or axioms themselves become the object of intense rigorous scrutiny. Abstraction is paramount.

According to van Hiele (1955/1986), progress from one level to the next involves five phase: information, guided orientation, explication, free orientation, and integration. The van Hiele developing the phase of teaching geometric describe as the following teaching model.

Phase1: Information and identification of geometric shapes. In this phase, students become acquainted with content domain. The researcher discusses materials clarifying the content, placing them at the child's disposal. Through this discussion, the researcher learns how students interpret the language and provides information to bring students to purposeful action and perception.

Phase2: Directed orientation. In this phase, students become acquainted with geometric objects form which geometrical idea are abstracted. The researcher role to direct student's activity by guiding them in diagrammatically exploration carefully structured, in which students manipulates objects so as to encounter specific concepts and procedure of geometry. Researcher should choose materials and task in which the targeted concepts and procedure are salient.

Phase3: Explication about figure. Students become conscious of the relation and being to elaborate on their intuitive knowledge. Thus, in this phase children become explicitly aware of the geometric conceptualizations, in their own language for the subject matter, teacher's role in this phase is to introduce the relevant mathematical terminology.

Phase4: Free orientations. Children solve problem whose solution requires the synthesis and utilization of the concept and relation previously elaborated. They learn to orient themselves within the "network of relation" and to apply the relationship to solving problems. The teacher's role is to select appropriate materials and geometric problems, to give instruction to permit various performance and to encourage students to reflect and elaborate in this problems and their solution and to introduce teems, concepts and relevant problem-solving processes as needed.

Phase5: Integration. Students build summary of all they have learned about the objects of study integration their knowledge in to coherent network that can easily

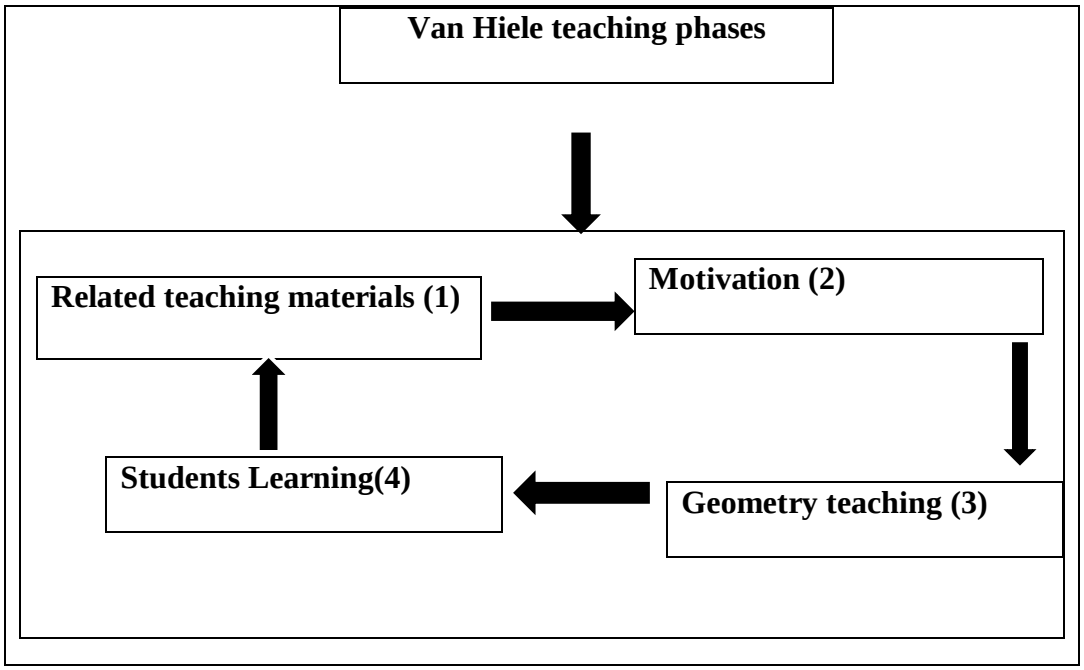
be described and applied. The researcher's role is to encourage students to reflect on and consolidate their geometric knowledge, increasing emphasis on their use of mathematical structures as a framework for consolidation. At the completion of phase five, a new level of thought is attained for the topic studied.

Therefore, the aim of the study was to investigate the effectiveness of van Hiele approach in teaching geometry at secondary level using the above discussed theoretical frame of learning geometry thought instruction in the class on the basis of experiment.

Conceptual Framework

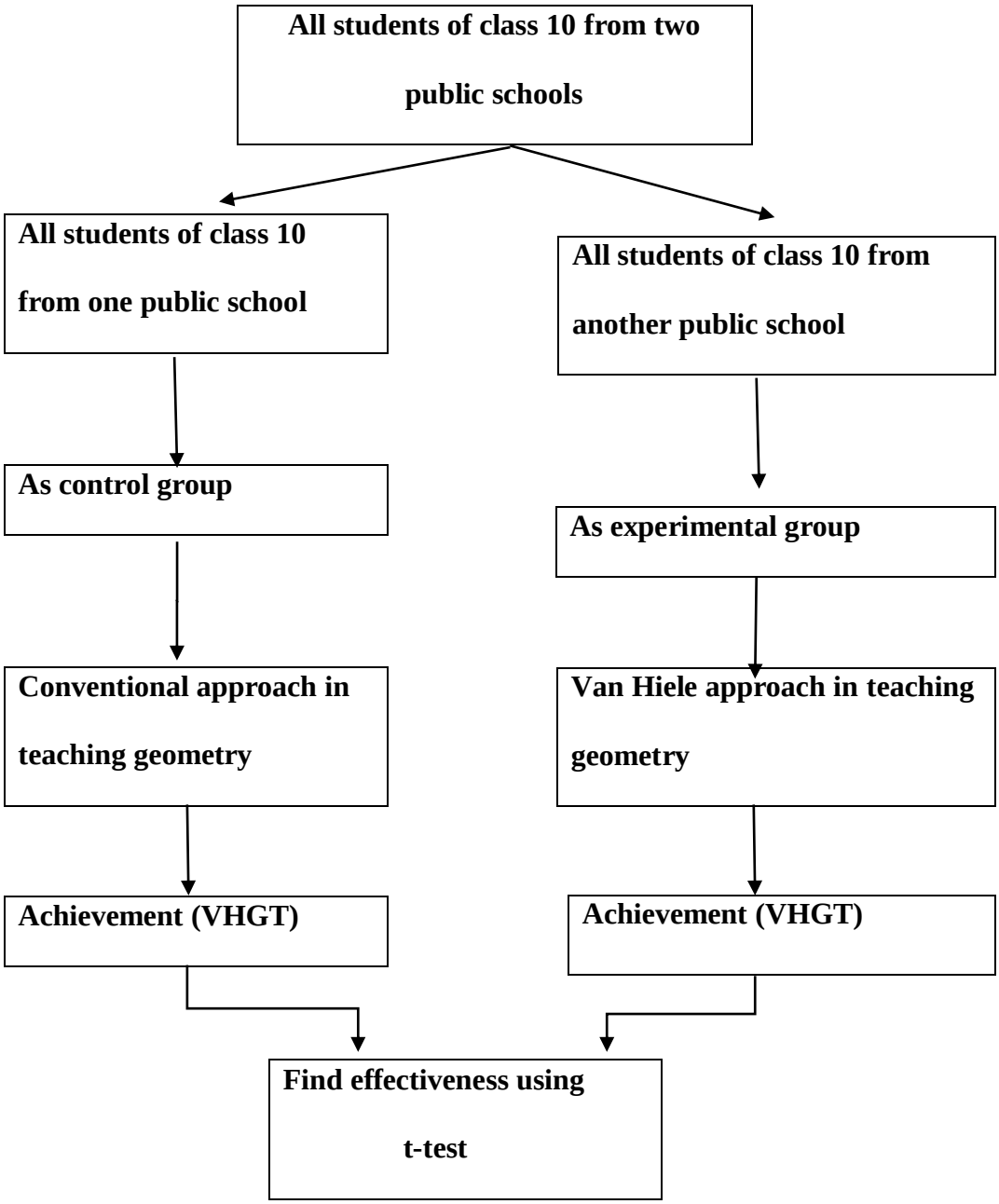
This study had used theory of van Hiele approach of teaching geometry at grade ten students. The conceptual framework is road map of the study. Teaching method, materials, environment, classroom management, student's motivation, etc. are main factor of teaching in classroom. The researcher drawn theoretical and methodical understanding as his needed on the basis of objectives. Researcher create the conceptual framework on the base of Jhosi(2017) *"Effectiveness of van Hiele approach in teaching geometry"*. The researcher modified the conceptual framework which as his need on the basis of objectives of the study.

Theoretical Understanding



`

Methodological Understanding



Motivation is the get way of the teaching learning activities. So the researcher using related materials and van Hiele phase base geometric learning theory of geometry teaching in classroom in secondary level. VH learning theory and related instructional materials are most supported the students' motivation of geometry teaching. Also, the van Hiele approach phase of geometry teaching easy to learned and visualized the abstract concept of geometric problem. So the researcher made the

above theoretical understand in his conceptual framework. The researcher developed the teaching episode basis were van Hiele phase base teaching geometry and applied in experimental group to measure and compare the achievement of geometry in grade ten students between experimental and control group. So the researcher made the above methodological understanding in the study.

Chapter III

Methods and Procedures

This chapter has focused on the methodology which was used to conduct this study. I particular, it includes the research design, population, sample and sampling method, research tools, data collection procedures and the data analysis procedures of this study. Furthermore, it explains the principle and method used in the preparation of test items, reliability and validity of the test items, and admiration of the test.

Design of the Study

Research design is the conceptual structure, strategy of the logical and direction of research. The research plan developed before starting the research work is a research design. Research design need to conduct the research in proper way, main importance is to help researcher to collect data, interpret and analyze. Experimental research designs have the most control, and, thus, allow researchers to explain difference between two groups. One of the key features of an experimental design is that participants are randomly assigned to groups. Experimental designs can be used to test differences between groups or factorial differences within multiple level of each group and a psychotherapy group. Many developed researches (Joshi 2017, Gyawali 2009, Lamsal 2005, Abudllah and Zakaria 2013 etc.) to check effectiveness manipulating by variables use experimental design. Also, this research is an experimental type design, having two groups: the experimental and control groups. Particularly, the pre-test and post-text non-equivalent control group design was adopted to fulfill the purpose of the study.

Population and Sample of the Study

All the grade ten students who were had enrolled within the year 2074 in the public schools of Galyan municipality of Syangja districts were considered the

population of the study. The researcher at first listed the complete list of all government secondary schools of Galyan municipality and then four schools were selected by random sampling method for the sample of the study. The list of selected schools has been given in appendix C.

Formation of Control and Experimental Group

Researcher visited these four schools himself and explained the purpose of the study with the head teacher and then took permission for the administration of the van Hiele geometry test (VHGT) which was the main tool of this research. This tool was adopted from the CDASSG (Cognitive Development Achievement in Secondary School Geometry) test used by Usiskin (1982) which is presented in appendix B. Van Hiele Geometric Test (VHGT) was administered during the period 2074/05/21 to 2074/05/26 in each school. After grading marks of all students of four schools (see at Appendix E) researcher used t-test for selection of two schools as an experiment of this research. The result of test showed that students of Satya shila Secondary and Narodaya Secondary schools have almost same learning ability in VH level. So the students of grade X of these two schools were selected for control and experimental groups. The experimental and control group were ensured by tossing the coin, as a result Narodaya secondary school was considered a control group and Sataya Shila school was an experimental group of the study.

Variables of the Study

Any image, perception or concept that is capable of measurement is called a variable. In other words, a concept that can be measured is called a variable. Mathematics achievements, van Hiele geometric test (VHGT), homework, talented students, classroom discussion, were considered the variables of this study.

Independent variable. They are also called change variable or movement variables. They are responsible for bringing the change. They are causes that are responsible for bringing about change in a situation or phenomena. Van Hiele Geometric Test (VHGT) was independent or movement variable of this study.

Dependent variable. They are also called outcome variables. Dependent variables are the outcome of the change(s) brought about by changing an independent variable. In this research, mathematics achievement was the dependent variable.

Extraneous variable. They are also called the variables that affect the relationship. There are several other factors in the real life situation, which may affect changes attributed to independent variable. These several factors which are not measured in the study and which may increase or decrease the magnitude or strength of the relationship between independent and dependent variables are called extraneous variable. Student's talent ship, homework, classroom discussion, family support, distance between home and school were extraneous variables of this study.

Control exercise of extraneous variable

In this study, two different schools were considered as an experimental and control groups. The selected students were almost same intellectual capacity according to mathematics achievement test of these schools. Researcher used Van Hiele approach in experimental group to teach geometric contents and conventional approach in control group to teach same geometric contents. All the variables cannot be controlled by the researcher likewise students home environment, student's maturation, statistical mortality, intelligence and communication. Therefore, some of the variables which can directly affect the researcher are tried to control by the researcher in the following ways.

Teacher variable. Researcher himself taught both experimental and control groups. He taught for two group during different period and same unit, which controls certain variable such as teacher qualification, emotion and other variables.

Subject matter. Same content was taught to both experimental and control groups from the same curriculum, same textbook prescribed by the government in Nepal.

Students. Two different groups were selected from two different schools (Narodaya and Satyashila secondary school). Students in both groups were different, which controls certain variable such as student's interaction, knowledge sharing and other.

Length of experiment. The researcher divided equal time during to teach both experimental and control groups. Researcher taught 20 days to both groups by van Hiele model phase of teaching geometry and traditional teaching approach in teaching geometry.

Stages of Experiment

There were three stages in conducting this study which was explained here as a stages of experiment. They were named as pre-experimental, experimental and post-experimental stages. These stagers are explained as follows.

Pre-experimental stage. In the pre-experimental stage, the researcher was developed the test item and the researcher selected experimental and control groups by tossing coin. Then the pre-test was taken to each group and mean value, standard deviation, coefficient of variance of each group were measured and calculated.

Experimental stage. In this stage obvious two separated groups were taught by different techniques i.e. experimental group was taught by using van Hiele model

and that of control group by traditional method of teaching geometry. Also, both groups were taught for one month in same contents from geometry.

Post-experimental stage. It is the last stage of experiment in which two groups had been taught by two different methods during experimental stage were evaluated by taking their post-test and then compared their mean achievement score, its standard deviation and coefficient of variance of each group obtained from pre-test and post-test. Also, the data were analyzed, interpreted and conclusion were drawn in addition to test the significance difference of their mean achievement scores by using the inferential statistics, namely the t-test at 0.05 level of significance.

Tools of Data Collection

Data collection is the important part of the study. This study was based on the data collected from primary and secondary data sources. In this study, following tools were used for data collection.

Van Hiele Geometry (VHGT): VHGT was main survey tool of this study for collecting data which was adopted from the CDASSG (Cognitive Development Achievement in Secondary School Geometry) test used by Usiskin (1982).The tool has been given appendix B. This test consisted of 25 multiple choice items of paper and pencil test with five purposed answer per items and five items per level. According to Usiskin, the items were written to correspond directly to statements from the Van Hiele about characteristics behavior of student exhibit at each level. However, the researcher used almost all twenty items that characterize the first four Van Hiele's levels. The study of geometry at level 5(Rigor) is highly abstract and does not necessarily involve concrete or pictorial models. At this level the postulates or axioms themselves become the object of intense rigorous scrutiny so the five items that characterize van Hiele level five are not solved by grade X students. They are not

expected to reach level five. VHGT matches the van Hiele theory, short and easy to administer, easy to apply. The text has been widely used teachers and researchers to determine van Hiele level of different students in geometry. The researcher administered the main data collection tool VHGT at pre-test and post-test.

Observation note: Observation was one of tools of data collection. Researcher made an observation format to consulting with the supervisor which in the Appendix-G and observe the classes basis for the conceptual framework. This format contains student's activities, van Hiele approach teaching phases, and shared personal practices. According to this format researcher observed the classes doing his experiment. Then researcher made conclusion form the observation note.

Interview Schedule. The research taught to experimental group with Van Hiele approach and taught control group with traditional method. Interview used discover the understanding of the students with schedule open ended questions about the effectiveness of van Hiele approach but there is flexibility to add and reduce question in accordance to the situation during the period of interviewing. The researcher developed interview format bases for the conceptual framework and consulting with the supervisor. This format contains six open-ended questions which are presented in appendix-H. Also, interview is taken format the experimental group only where ten students were interviewed. In interview process, the research not only asking the question but also observed all behavior and answering method of respondents.

Reliability and Validity of Tools

Reliability is the degree to which a test consistently measures whatever it measures. The repeated administrations of the tests are essentially same, then we can have that the score obtained from the test is confidently more reliable. Thus reliability

refers as the consistency of the results. In this study reliability was determined through the application of test re-test method. The correlation is a statistical tool which studies the relationship between two variables. To check reliability, researcher administered two tests among 25 students of Sishu Kalyan Secondary School for 30 minutes' time of interval. Researcher calculated correlation using by Spearman's Rank correlation coefficient formula when Rank was repeated (see Appendix D). The correlation coefficient was found to be 0.83. Hence, there was substantial positive correlation between test and re-test result. This showed that reliability of research tool was well.

Validity is an important key to effective research, if a piece of research is invalid then it is worthless. Therefore, the instruments used in this study were checked for validity. The documents analyzed were found to be validity because they were all consistent with Nepalese education system. The van Hiele Geometry test was first developed by Usiskin (1982) to test the geometric reasoning of the American students, Atebe (2008) adopted this test for their study with the Nigerian and South African students. This study was similar to those of Usiskin (1982) and Atebe (2008). Therefore, researcher adopted test which was used by Atebe (2008). Knowing that the adopted version of the test was based on the mathematics curricula of Nigeria and South Africa the researcher piloted it in order to check for the suitability on the Nepalese Context.

Data Collection Procedures

The researcher himself visited all four participating schools and explained the purpose of his study again with head teacher and related school management committees and took permission for pre-test. Researcher developed the data collection tool first twenty items of VHGT as main tool. Also, the researcher used the

constructed test item in another school (Sishu Kalyan Secondary school) grade X students to maintain reliability. The researcher took pre-test in 2074/6/26 existed four groups at grade X in Satay Shila, Narodaya, Rastiya and Bhanu secondary school Glyan Municipality. After selecting experimental and control group among these four groups, these two groups were taught by researcher himself for one month (2074/7/1 - 2074/7/30). The researcher taught the experimental group in Morning period of each school day by van Hiele model phase of teaching geometry with developed teaching episode at Sataya Shila secondary school. Also the control group was taught using conventional approach of teaching geometry in evening period of each school day at Narodaya Secondary school.

At the end of teaching, the VHGT (same pre-test) was administered in both groups for 2074/8/3 of students. They were inspired to answer freely and without any discussion among themselves. The time allotted to the test was 25 min. which was stipulated based on the calculation of average time taken by each student in pilot testing.

Test Administration

This test was meant to be answered by all students those participated in two schools of this study. The students provided their answers of the VHGT on multiple choices answer sheets (see appendix B). Thus the VHGT was administrated by researcher himself as pre-test with the help of mathematics teachers of the respective schools at 2074/6/26. Pilot testing indicated that this VHGT could be complete in 25 minutes. Therefore, 25 minutes was allowed the students to complete the VHGT. Also, the VHGT was administrated by researcher himself as post-test with the help of mathematics teachers of these two respective schools (Naroday and Satyashila Secondary school) at 2074/8/3.

Test Grading

After the time direction of examination, the answer sheets were collected. Also the answer was scored by the researcher and then the scores were tabulated for the analysis. All data was quantitative. Two grading methods were employed for the purpose of grading students in the VHGT where in first grading method each correct response to the 20 multiple choice items was assigned one point. Hence, each students score ranges from 0-20 marks. Similarly, the second method of grading VHGT was based on the "3 of 5 correct" success suggested by Usiskin (1992, p33) According to "3 of 5 correct" grading system, the students be successful preform at each van Hiele level if he/she has correct answer of any three of five at each VH level. if not students are unsuccessful at respective level.

Data Analysis Procedure

The statistical t-test was used in the study to find out whether there was significant difference between the geometric achievement for van Hiele teaching approach and conventional approach. Descriptive statistics such as mean, standard deviation, and variance of both experimental and control groups were calculated to know the difference of achievement before and after experiment. In this case two normal population with unknown variance, t-test used to compared and find effectiveness the mathematics achievement in geometry of students where the value of significance of research study was 0.05 with $(n_1 + n_2 - 2)$ degree of freedom and where n_1 and n_2 are the number of students in the control and experimental group. The researcher used the following statistical procedure to analysis obtain data: mean, standard deviation, variance and t- value. Also were calculated as the scores obtain by the students to compare the result of pre-test and post-test.

The collected data were analyzed and interpreted by using statistical devices by giving critical appraised using the following procedures; Student's score in each van Hiele level was added to obtain the total raw score and then it was converted into percentage score for the simplicity for the comparisons. Mean was used to find level wise mean score of the students in the Van Hiele geometry test. Also percentage numbers of students were interpreted in terms of their corresponding van Hiele level. The coefficient of correlation was used to find the degree of consistency of test. A parametric test, t-test was used to find the effectiveness of van Hiele level of geometric thought in teaching geometry at secondary level.

For qualitative data, researcher observed the classroom of both groups within the experimental duration. He prepared the daily notes of students' activities in the classroom such as participation, discussion and problem solving techniques. The researcher took interview of ten students from experimental group. Then the researcher tried to find out the effectiveness of van Hiele approach in teaching geometry. Finally, the collected data were scored and tabulated by researcher analyzing the answer of the students'.

Chapter IV

Analysis and Interpretation of Data

This is an experimental research related to find effectiveness of the van Hiele approach in teaching geometry at secondary level, particularly at grade X. The objectives of this study were to compare the van Hiele approach and conventional approach of teaching geometry at grade X students and to find out the level of achievement of students in geometry according to van Hiele at grade X students. Pre-test, post-test, non-equivalent group design was adopted. For this, 25 students were taken as control group from Narodaya secondary school and 25 students were taken as experimental group from Satya Shila secondary school. The main tools of data collection were VHGT. Pre-test was administrated before starting the experiment and the post-test was administrated after the experiment. Then, comparing the achievement score of VHGT of pre-test and post-test of both group were analyzed by using t-test at 5% level of significance. To maintain reliability of test the researcher used test re-test method. Likewise, to find the level of students in geometry according to VH level the researcher used method of grading VHGT which was based on the "3 of 5 correct" success suggested by Usiskin. The collected data were analyzed and interpreted under the headings: level of students at VH level, compeering of mean achievement score of experimental and control groups on pre-test and post-test in this section. Similarly, the non-cognitive effects during the experimental period on both experimental and control groups were analyzed and interpreted at the end of this section.

Level of Students in Geometry According to VH level

Students' performance of VHGT at pre-test and post-test (using by episodes) of two groups has been given in appendix D and F respectively. Their scores on

VHGT was analyzed in order to determine the number and percentage of students at each van Hiele level separately for each group at pre-test and post-test. The '3' of '5' correct success criterion was used in classification method.

Table 1.Number of Students at each VH level of Control Group at Pre-test.

VH level	No. of students	Percentage
0	8	32%
1	8	32%
2	5	20%
3	1	4%
4	0	0%
total fitting	22	88%
No fit	3	12%
Total	25	100%

Table 1 shows the more students 8 (32%) are below the basement van Hiele level 1 out of 25 students in the beginning. This imply that they are not in reasoning even at other than visual level. Likewise, out of 25 students 32% and 20% students are at VH level 1 and level 2 in the pre-test. At pre-test, a total of 22 learners (82%) were assignable to various van Hiele levels. In other words, 3 (12%) of them did not 'fit' this classification scheme.

Table No.2 Number of Students at each VH Level of Control Group at Post-test.

VH level	No. of students	Percentage
0	7	28%
1	6	24%
2	8	32%
3	2	8%
4	0	0%
total fitting	23	92%
No fit	2	8%
Total	25	100%

Table 2 shows the more students 7 (28%) are below the basement van Hiele level 1 out of same 25 students after finished 20 usual classes. Thus most of students were still functioning at recognition level. Table 2 shows that 24% and 32% students are at VH level 1 and level 2 after finished these 20 usual classes respectively. This shows that few students increase after teaching class at level 2 but not as expectation. It also indicates that small portion of the students (i.e 4%) is at van Hiele level 3 on beginning test, some other students good perform at level 3 on test of after teaching. Table 2 shows 8% students are in the VH level 3. At post-test, these students (92%) show performance any one of van Hiele level. After experiment, only one students fit on van Hiele level, thus at last, 2(8%) students did not fit any VH level.

These two tables (table 1 & table 2) implies that the majority of the learners in the study had difficulty in dealing with problems concerning class inclusion and the relationships between the properties of various simple geometric shapes and between different shapes. Similarly, tables indicate that using the modified van Hiele level

assignment scheme, students level according to van Hiele phase of learning geometry is almost same.

Table 3.Number of Students at each VH Level of Experimental Group at Pre-test

VH level	No. of students	Percentage
0	10	40%
1	7	28%
2	4	16%
3	0	0%
4	0	0%
total fitting	21	84%
No fit	4	16%
Total	25	100%

Table 3 shows that the differences of functioning at each van Hiele level of students before experiment. Table 3 shows the students 10 (40%) are only recognize VH level 0 according to '3' of '5' van Hiele modified theory. Likewise, table 3 indicate that out of 25 students only 11 students are at VH level more than VH level 0. Hence table 3 shows that the majority of the learners can't performance another VH level other than VH level 0. Thus, students of experimental group are not functioning at level 2 & 3 well, they are only limited VH level 0 & 1. Table 3 help to researcher to establish his second objective that is level of students at each van Hiele level. Also table 3 shows that the level of students is not reform at pre-test and post-test time while teaching by conventional approach. Thus, conventional approach is not more supported to learn geometry.

Table No. 4 Number of Students at each VH Level of Experimental Group at Post-test.

VH level	No. of students	Percentage
0	1	4%
1	8	32%
2	10	40%
3	5	20%
4	0	0%
total fitting	24	96%
No fit	1	4%
Total	25	100%

Table 4 shows that the differences of functioning at each van Hiele level of students between before using teaching episodes (experiment). At post-test more then 1 (4%) student is functioning at over VH level 0 else 1 no fit student. Thus, table 4 shows that 23 students show their performance at over VH level 0. Table 4 shows that the majority of learners perform at VH level 3. Thus, students of experimental group are functioning at level 2 & 3 well, not only limited VH level 0 & 1 at post-test.

Table 3 & 4 helps to researcher to establish the level of students according to van Hiele level thinking at geometry in the post-test and pre-test. It also help to researcher effectiveness of VH level of geometric thought in teaching geometry at secondary level. There are no students reasoning at deductive level. This fact suggests that even some students construct a formal proof of a theorem they do not understands well. It justifies that tenth grade students are not capable of understanding the meaning of axioms/postulates, meaning of converse and sufficient condition, role of

undefined terms, axioms, definitions and theorems as a way of establishing geometric theorems with in an axiomatic system.

Analysis of Pre-test Result

Score of the pre-test of the students of experimental and control groups are presented in Appendix E. Also the statistical calculation of pre-test of both groups is presented in Appendix F and summarized in table 5.

Table No. 5 Comparing of pre-test Result

Group	N	Mean	Variance	Standard Deviation	F	α	Calculated value	Tabulated value
Experimental	25	7.48	4.4096	2.0999	1.19	0.05	1.19	1.98
Control	25	7.92	5.2736	2.2964				

The above table shows that there were equal i.e. 25 students in both experimental and control groups. In pre-test 20 marks of van Hiele geometric test was administered in which each question's marks was one (see the question in appendix B and score of students in appendix F). The mean, variance and standard deviation of experimental group were 7.48, 4.4096 and 2.0999 respectively. Similarly, the mean, variance and standard deviation of control group were 7.92, 5.2736 and 2.2964 respectively. Hence tabulated f-value was 1.98 at 0.05 level of significance. That the calculated f-value was calculated value 1.19 is less than tabulated value 1.98 ie. $1.19<1.98$. So H_0 was accepted. It has been given at appendix G. Hence it was concluded that there is no significance difference between mean achievement score of

experimental and control group in the pre-test of VHGT. Both the groups have nearly same ability in pre-test.

Analysis of Post-test Result

Score of the post-test of the students of experimental and control groups are presented in Appendix H. Also the statistical calculation of pre-test of both groups is presented in Appendix I and summarized in table 6.

Table No.6 Analysis of post-test Result

Group	N	Mean	Variance	Standard Deviation	α	Calculated t-value	Tabulated t-value
Experimental	25	11.84	2.28	1.5099	0.05	4.001	1.96
Control	25	9.96	3.2384	1.7995			

The mean and standard deviation of the scores of post-test of experimental and control groups are 11.84, 9.96 and 1.5099, 1.7995 respectively as shown in the above table. Post-test was taken for the propose to find out the level of achievement score in mathematics of both control and experimental group after conducting treatment. Above table shows that the calculated t-value (t=4.001) is exceed critical value (α=0.05) at 5% level of significance. The detail information about table no.6 has been shown in Appendix-J. Therefore, we accepted the alternative hypothesis in the achievement score of both groups. This mean after conducting the treatment to the both groups experimental and control had different level of achievement score in mathematics. So, analyzing the result of post-test conducting of both groups the level of achievement in geometry learning was found higher in experimental than control

group. Therefore, I claim that that the reason of getting higher level of achievement of experimental group that control group is the effect of van Hiele approach phase of teaching geometry. There are no other variables to affect in the result of this experimental group.

Effectiveness of Van Hiele approach in Teaching Geometry

In order to analyze the achievement in geometry achievements test was administered among the grade X students of the selected schools. From the pre-tests the researcher found that same achievement score of two groups by the statistical treatment. That means there is no significance different between two group achievement scores of geometries. Later, the researcher took post-test of both groups after experiment. From the post-test the researcher found that achievement scores of experimental group is better than the control group.

Non-cognitive Effect

Researcher developed observation note to see non-cognitive effect. Then the researcher observed the students in different situation with used Appendix-G and daily note they were noted. The researcher observed students' motivation, student's class activities and student's class behavior change in mathematics teaching classroom.

The students of experimental group seemed to be more satisfied with the van Hiele approach in teaching geometry. They expressed their common attitude that this new method made them easy to understand the geometry exercise. The students of control group could not easily understand the geometric problems and they seemed motivate in the class. The students of control group were seemed monotonous and not interested in geometry teaching. As other different experimental researches have shown van Hiele approach is more applicable and effective in teaching geometry I

found this approach effective through experiment and from the students' behavior. Most of students were found motivated in the class while teaching geometry using the van Hiele approach in teaching phases. The classroom seemed really interesting for both students and teacher while teaching with this approach. On the other hand, the students of control group paid no interest to the geometry portion. From the observation note I found that abstract problem of geometry was difficult to the students. They did not participate in the group discussion and group work. Also, the student's achievement score of post-test is better than the pre-test score. The students of experimental group were regularly participated in the class did homework, discussed the geometrical problems by consulting the teacher.

Student's Point of View

Researcher developed interview schedule question. Then take the response of students in different situation of the students with used Appendix-H. In experimental group must of the students' from interview said that *"Van Hiele approach in teaching geometry is more applicable and effective approach. Geometry is visualized subject in which teacher used many materials in teaching geometry and geometrical problems can be understood by using phase of van Hiele approach in teaching geometry. So, almost of the students said that they like Van Hiele approach in teaching geometry".* As other different experimental researcher has shown van Hiele approach is more applicable and effective in teaching geometry I found this approach effective through experiment and from the students' view. Moreover, the most of the students' from interview said that *"Van Hiele phase of teaching geometry is more enjoyable and memorable because Van Hiele approach adopts simple to complex method, effective teaching materials, students-teacher discussion and visualizing the abstract concept geometry."* This shows the Van Hiele five phases in teaching geometry are simple to

complex technique. So, the researcher found that same perception in students in his experimentation.

Most of the students' were found motivated in the class while teaching geometry using the Van Hiele approach in teaching phases. The classroom seemed really interesting for both students and teacher while teaching with this approach. Likewise, the students said that *"Van Hiele approach in teaching geometry is* different *and effective than the traditional approach in teaching geometry. Traditional method is limited only in problem solving without using teaching materials and it is teacher oriented. So, the geometry is an abstract subject and cannot be understood easily through traditional method. But, Van Hiele approach phase of teaching geometry adopts simple to complex technique, such as visualizing the abstract concept of geometry by using suitable teaching material".* So, Van Hiele approach in teaching geometry is more effective in teaching geometry than the traditional method in teaching geometry.

Above explanation of observation note shows that van Hiele approach in teaching phase of geometry was better to teach geometry at secondary level than conventional method. Most of students were interested to van Hiele approach in teaching activities. Students believed that van Hiele approach support easier understanding geometric concept and using learning by doing and group discussion process. Thus van Hiele approach to support the students learn geometrical concept.

Chapter - V

Summary, Finding, Conclusion and Recommendations

This study was an experimental whereas researcher developed two types teaching activities conventional and VH approach. Researcher used van Hiele approach in experimental group and conventional method in control group. After the experimental stage the researcher took the VHGT one each group. On the basis of achievement of the students the researcher obtained following summary, finding, conclusion and recommendation.

Summary of the Study

The nature of this study was experimental types of study. The main purpose of the study was to measure effectiveness of van Hiele approach in teaching geometry at secondary level. To fulfil the purpose of study the researcher compared the achievement of the students in teaching geometry by van Hiele approach with achievement of the students taught by conventional approach in teaching geometry. In this study the researcher reviewed research papers and related theoretical literature to van Hiele approach in teaching geometry and thinking level of students.

For the data collection of the study researcher selected four schools from Galyan municipality of Syangja district using the random sampling method. Then researcher took pre-test from the same class's ten, analyzed data and selected two schools for two groups. Researcher made experimental and control groups by method of rolling the coin. Also, the researcher used van Hiele approach in experimental group and conventional approach in control group taught them geometry. After that researcher taught with the developed stages and observed the class activities and student's behavior. Therefore, the researcher took post-test of both groups according

as VHGT. Both tests consisted 20 objectives multiple types item and each question has five options (VHGT).

The researcher analyzed result of pre-test and post-test of both group by using statistical devices such as mean, standard deviation, variance and t-test on the basis of topic analysis of pre-test. Then comparing the achievement of both groups experimental and control groups' post-test data analysis. The information collected from the pre-test and post-test then researcher analyzed organization of data, summarizing the data and interpreting the data.

Findings

From the existing statistical analysis of the data leads towards the following result as major findings of this study. The achievement of grade X students who were taught geometry with using van Hiele approach teaching achieved better achievement than the students who were taught using conventional methods. And the level wise performance at VH level of students who were taught geometry with using VH approach teaching was better than the students who were taught using conventional approach. It was found that the average score of the students of experimental group is higher than average score of the students to control group. Statistically the mean different was significant. Thus it was concluded that van Hiele approach in teaching geometry was effective approach in teaching experimental verification of geometry at lower secondary level. The researcher was drawn following finding.

- Analysis of the mean, SD, variance, and t-test of the score obtained by experimental group and control group students in pre-test showed two groups were equivalent or homogenous before the treatment. It is no significance difference between mean achievement of experimental and control group.

- Analysis of level wise performance by these group of students in pre-test nearly same.
- The student's achievement of the post-test was greater than student's achievement of the pre-test. This shows that both teaching approaches help to learn geometry teaching in secondary level.
- Analysis of the post-test score at each van Hiele level of each groups showed that the level wise performance of experimental group was better than control group
- Analysis of the post-test mean score between the experimental and control groups showed that there was significance difference to each geometry to both groups. The experimental group was taught using van Hiele approach and get better results in comparison to a control group.
- Finally, the main fining of this study was "van Hiele approach in teaching geometry is effective than the conventional approach in teaching geometry" at secondary level students.

Conclusion

On the basis of finding, which are presented in the previous section, conclusion of the study can be drawn the teaching strategy through van Hiele level of geometric though is more effectiveness than conventional teaching approach in teaching geometry at secondary level. This study revealed that students of grade IX were not adequately prepared to understand the concept of geometry. As the most of the students in this study were bellow VH level 2 at pre-test time. The majority of the students have poor conceptual understanding in geometry due to their emphasis in mechanical and procedural learning. But learning theory, van Hiele level of geometric though helps to change the mechanical and procedural learning in to meaningful and

reasoning and majority of the students in this study were above the VH level 1 at post-test time. The other main conclusion reached was that there is more effectiveness van Hiele level of geometric though teaching approach than conventional teaching approach in this study. Thus the poor performance of more students on mathematics was strong associated with being at the lower van Hiele level. So, the students' level of thinking plays a very important role in the learning of whole mathematics. From the result of this study it can be conclude that the van Hile;s levels of thinking helps the students to understand geometric ideas and consequently perform better in achievement test more than conventional teaching in geometry. Its effectiveness is more in geometry teaching than others approaches. Additionally, the van Hiele levels of thinking help students to motivate and apply the known geometrical concepts in unfamiliar condition.

Furthermore, this study supports that level of reasoning in geometry are hierarchical. The result of the VHGT attested that the van Hiele theory holds and is a useful tool to determine student's geometric reasoning. This study supports the claim that van Hiele theory is one of the best frameworks in exploring student's geometric reasoning.

Recommendations for Stakeholder

On the basis of above findings and conclusions, the following recommendations are presented:

- The majority of the students were found bellow of VH level 2 at pre-test but at post-test the majority of students were found above of VH level 2, so classroom should be conducted with geometry concept from lower level.
- Many students in this study were able to recognize shapes only in standard orientation from teaching episodes according to van Hiele five phases. So

teacher need to provide students with great opportunities for exploring the properties of simple geometric shapes in different orientation. During this activity, the invariant properties of the shapes should be emphasized.

- Curriculum designers, text book makers and mathematics teachers need to know about van Hiele level of though and also should know how to make teaching episodes according to van Hiele five phases: information, guided orientation, explication, free orientation and integration.
- Teacher trained centers and other intuitions that are responsible for preparing the school mathematics teachers need to import the effectiveness of van Hiele theory in teaching school geometry.
- Mathematics teacher to be aware of the levels of thinking that characterize each of van Hiele level may help to reduce the mismatch between their teaching methods and learner's cognitive thinking level.
- Teacher can remove mathematical anxieties of learners and to increase interest and motivation in learning geometry with this learning process.
- Since, the van Hiele theory forms the fundamental of mathematics curriculum for country such as USA, Britain, Netherlands and Russia etc (mattaya, p. 106) It is recommended that Nepalese mathematics curriculum should also align itself with the van Hiele theory.

Suggestions for the Further Study

The researcher has been found the following suggestions for further study:

- This study was confined only 25 students each of two groups. They were 10^{th} grade students of different two schools of Galyan municipalities, Syangja. Therefore, further studies can be done in different classes of school in different district of Nepal and the result of the study can have generalized.

- Same study can be done in lower secondary and primary level and different classes of different levels.
- A study can be done to investigate whether the Nepalese mathematics curricula and aligned with van Hiele theory or not.
- In this study researcher employed only paper-pencil test namely VHGT to assess the students van Hiele level. It is suggested that clinical interview, hands-on activities along with VHGT can be used to assess students reasoning level. The data obtained thus from the different tools can be triangulated to assign students VH level more accurately.
- It would be valuable to explore, in the light van Hiele theory, whether the class room instructions in schools are being practiced or not by using check list of VH phase descriptor.

References

Atebe, H. U. (2008). *Students van Hiele level of geometric thought and conceptual in plane geometry: A case study of Nigeria and South Africa.* A doctoral thesis, Rhodes University

Celements, D. H. (2004). *Perspective on the childs thought and geometry.* Restan: National Council of teachers of Mathematics.

Chaulagain, R. K. (2005). *A study on problem faced by secondary school mathematics teacher in teaching geometry of Kathmandu district.* An unpublished master's thesis, T. U., Kritipur, Ktm.

Fuys, et. Al. (1988). *The van Hiele model of the development of geometric thought*. An unpublished master's thesis.

Gyanwali, S. (2009). *Effectiveness of Van Hiele, approach in teaching geometry at secondary level.* An unpublished master thesis, T.U., Kritipur, Ktm.

Halim, A.& Zakaria,E. (2013). *Enhancing students' level of Geometric Thinking through Van Hiele's phase-based learning.* Department of Science and Mathematics Education, Faculty of Education, University Technolog Malaysia.

Hiele, P.V. & D. V. (1957). *The didactics of geometry in the lowest class of secondary school (Ed. and Trans.).*Ph.D. Dissertation University of Utrecht,1957

.Hiele, P. V. (1959a). *The problem of inside in connection with school children's inside into the subject matter of geometry (Ed.and Trans.).* Unpublished doctoral dissertation. University of Utrecht.

Hiele, P. V. (1959b). *The childs thought and geometry (Ed.and Trans).* Reprinted

from Bulletikin deL` Association des professors de Mathematiques del' Enseignment public.

Hiele, P.V. (1980*). Level of thinking: how to meet them, how to avoid them.* Paper presented to the research precession prior to the 58th Annual meeting of the National council of teachers of Mathematics, Seattle.

Hiele, P. V. (1980*). Structure and insight.* New Yourk Academic press.

Hoffer,A. Jaime,A. & Fortuny, J. (1991). An alternative paradigm to evaluate the a*cquisition of the van Hiele levels.* Journal for research in mathematics education

Koirala, H.P. (1981). *Identification of geometrical concepts need for prospective secondary school teachers.* An unpublished master's thesis, T. U., Kritipur, Ktm.

Lamsal, S. (2005). *A study on the effectiveness of Van Hiele approach in teaching geometry at lower secondary level.* An unpublished master's thesis, T. U., Kirtipur, Ktm.

Maharajan, H.B. Upadhaya, H.P. & Paudel, L.N. (2058). *Teasing mathematics in secondary school.* Kirtipur, New Hira Book Enterprise.

Oli, N.(2014). *"van Hiele level of geometric thought and mathematics achievement of students, a survey study in Rukum districts."*An unpublished master's thesis T.U. Kritipur , Ktm.

Pandit, E.R. (1999). *A study of attitude of secondary level students and teachers towards geometry.* An unpublished master's thesis T.U., Kirtipur, Ktm.

Pandit, R.K.(2000). *A comparative study of achievements in geometry of eight grades in Lamjung district.* An unpublished master's thesis, T.U., Kirtipur, Ktm.

Paudel, D.P. (2007). *A study on problem faced by lower secondary school mathemics teachers in teaching geometry.* An unpublished master's thesis, T.U., Kirtipur, Ktm.

Pusey, E.L. (2003). *"van Hiele model of reasoning in geometry: A literature review*" A master theses, North Carolina State University.

Sharma, L.N. (1997). *A study of understanding of geometric ideas by grade VIII students of Gorkha district.* An unpublished master's thesis, T.U. Kirtipur, Kathmandu.

Shrestha, M.B. (2008). *Van Hiele model of thinking. A structure of thinking in geometry.* Mathematics education Forum. I(23)

Sharma, S. (2005). *"Effectiveness of van Hiele model of thinking at theoretical level for secondary school geometry in Nepal."* An unpublished thesis, T.U. Kirtipur, Kathmandu.

Ususkin, Z. (1982). *Van Hiele and achievements in secondary level geometry.* (Final Report of the Cognitive Development and Achievement in secondary School Geometry Project) University of Chicago, Department of Education.

Usiskin, Z. (1987). *The Van Hiele level of achievement in geometry.*

Usiskin z.& Senk,s.(1990).*Evaluating a test of van Hiele levels: a response to Crowley an Wilson.* Journal for Research in mathematics education.

Wilision, M. (1990). *Measuring a van Hiele geometry sequence, a reanalysis.* Journal for research in mathematics education.

APPENDIX-A

Consent Letter to the Principal/Head teacher

University Campus, kirtipur

Date: 2074

Subject: Seeking for help and permission

Dear Sir,

I am a students of M.Ed. second year studying at University campus (TU) Kirtipur. I am undertaking a thesis on the topic "Effectiveness of van Hiele geometric thought in teaching geometry at secondary level." For this study, I selected four schools from 16 Government school of Galyn municipality using by random sampling. So I am required to write a research report. I am primary concerned about assessing the students van Hiele level of geometric reasoning and explore the effectiveness of van Hiele level of geometric thought in teaching geometric. For this purpose, I intended to administer the standardized van Hiele geometric test on our students of Nepal. It was developed by J.I.Usiskin (1982) and widely used in America. If students' learning ability of yours school matches another three school of students, I will teach at least 20 episodes. I also need that periods, if this condition hold. This study will provide valuable information regarding our van Hiele level of reasoning in geometry and thereby planning for revision in the curriculum and instructional process.

Any information provided by school or obtained from students will be kept confidential and private. Moreover, the information obtained will not be used for any other purpose except the research.

I would be grateful to you if you allow me to administered the test and another if will be need and provide information

Yours sincerely

APPENDIX B

Answer sheet of VHGT

VAN HIELE GEOMETRIC TEST (VHGT)

lgb]{zgx? (Instructions)

!=of] kl/lf0f kq vf]Ng] geg] ;Dd vf]Ng' x'b}g. (Do not start until you are told to do so.)

@=s[kof vfnL 7fFpdf pko'Qm ;'rgf eg{'xf];\. (plese fill the appropriate information in the space

bellow)

gfd(Name):…… ……. ……

ljwfnosf] gfd(Name of school): ……

sIff(class) ……. lnË(Sex):…….. pd]/(Age)…….

#= oL j:t'ut k|Zg h;df @) cf]6f ax'a}slNks k|Zgx? 5g. k|To]s k|Zgx?df % cf]6f lasNkx? lbO{Psf] 5. h;dWo Pp6f dfq ;xLljsNk 5. k|Tos k|Zgx? Wofgk'j{s k9]/ o; pQ/ k'l:tsfdf /x]sf] ;+alGwt k|Zgsf] ;xLljsNkdf -Ó_ lrgf] nufpg'xf];\. t/ k|Zgkqdfg} lrgf] gnufpg' xf]nf. pQ/ k'l:tsfdf ePsf] vfnL 7fFp lrq sf]g{sf] nflu k|of]u ug{ ;lsg] 5. (This is an objective test, consisting 20 multiple choice questions. Each question is followed by options lettered A to E. There is only one correct answer to each question. Read each question carefully and tick (√) the correct answer on this answer sheet. Do not mark your answers on the test booklet.)

lrq sf]g]{ 7fFp(Space for drawing)

1	A	B	C	D	E
2	A	B	C	D	E
3	A	B	C	D	E
4	A	B	C	D	E

5 A B C D E

6 A B C D E

7 A B C D E

8 A B C D E

9 A B C D E

10 A B C D E

11 A B C D E

12 A B C D E

13 A B C D E

14 A B C D E

15 A B C D E

16 A B C D E

17 A B C D E

18 A B C D E

19 A B C D E

20 A B C D E

VAN HIELE GEOMETRY TEST (VHGT)

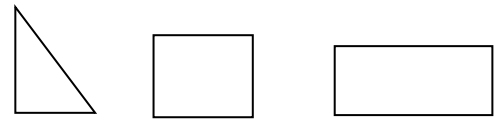
Time: 30 min.

1. lbOPsf] lrqx? s'g s'g au{ x'g<(Which of these are square?)

   A. K dfq (K only)

   B. L dfq (L only)

   C. M dfq (M only)



K L M

   D. L / M dfq (L and M only)

   E. ;a} ju{ x'g. (all are squares)

2. lbOPsf lrqdWo s'g s'g lqe'h x'g<(Which of these are triangles?)

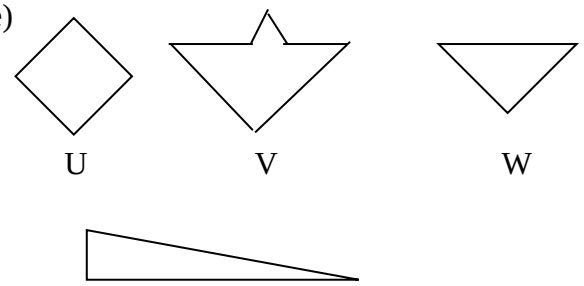
   A. s'g} klg xf]Ogg\. (None of these)

   B. V dfq (V only)

   C. W dfq (W only)

   D. W / X dfq (W and X only)

   E. V / W dfq (V and W only)



U V W X

3. lbOPsf lrqx? dWo cfot s'g s'g x'g<(Which of these are rectangles?)

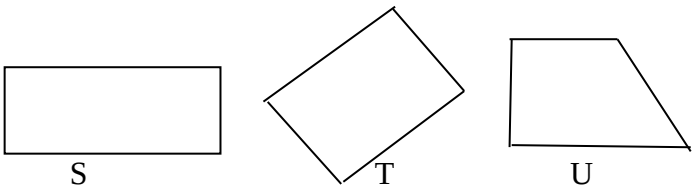
   A. S dfq (S only)

   B. T dfq (T only)

   C. S / T dfq (S and T only)

   D. S / U dfq (S and U only)

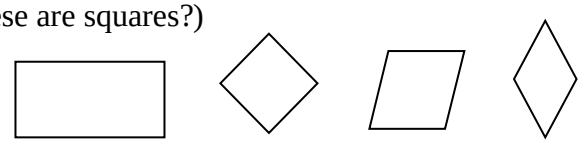
   E. ;a} cfot x'g. (all are rectangle)



S T U

4. lbOPsf lrqx?dWo] s'g s'g ju{ x'g<(Which of these are squares?)

   A. s'g} klg ju{ xf]Og. (none of these are squares?)



B. V dfq (V only)

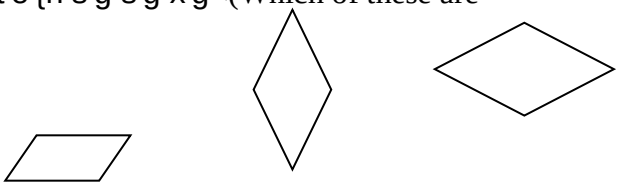
C. U / V dfq (U and V only)

D. W / X dfq (W and X only)

E. ;a} ju{ x'g. (all are squares?)

U V W X

5. lbOPsf lrqx? dWo ;dfgfGt/ rt'e'{h s'g s'g x'g<(Which of these are parallelograms?)



A. J dfq (J only)

B. L dfq (L only)

C. J / M dfq (J and M only)

D. s'g} klg xf]Ogg\.(none of these are parallelogram)

E. ;a} x'g (all are parallelogram)

J L M

6. PQRS Pp6f ju{ xf]. ;a} ju{df ;frf] x'g] cj:yf s'g s'g xf]<(PQRS is a square. Which relationship is true in all squares?)

A. PS / PR sf] nDafO a/fa/ x'G5. (PS and PR have the same length)

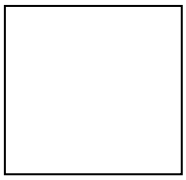
B. QS / PR Ps cfk;df nDa x'G5g. (QS and PR perpendicular)

C. PS / QR Ps cfk;df nDa x'G5g. (PS and QR perpendicular)

D. PS / QS sf] nDafO a/fa/ x'G5. (PS and QS have same length)

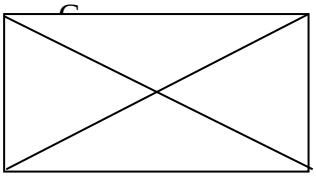
E. sf]0f Q sf]0f R eGbf 7'nf] x'G5. (angle Q are greater than angle R)

P Q S R



7.cfot GHJK df GJ / HK las0f{x? x'g, tnsfdWo k|Tos cfotdf ;Ffrf] gx'g] s'/f s'g xf]<(in the rectangle GHJK, GJ and HK are diagonals, Which of (A)-(D) is not true in every rectangle)

H G



A. rf/cf]6f ;dsf]0f x'G5g. (there are four right angles)

B. rf/cf]6f e'hf x'G5g. (there are four sides) K

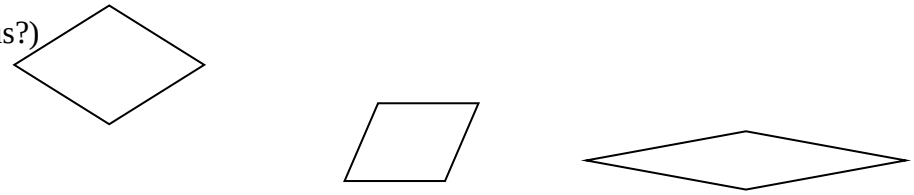
J

C. las0f{x?sf] nDafO a/fa/ x'G5g. (diagonals have the same length)

D. lakl/t e'hfx?sf] nDafO a/fa/ x'G5g. (opposite sides have the same length)

E. (A)-(D) ;a} ;To x'g. (all of (A) to (D) is true in every rectangle)

8. ;djfx' rt'e'h{ rf/ cf]6} e'hfx? a/fa/ ePsf] lrq xf]. oxFf # cf]6f pbfx/0fx? lbOPsf] 5. k|Tos ;djfx' rt'e'{hdf (A)-(D) s'g ;To x'b}g<(a rhombus is a four sided figure with all sides the same length. Here are three examples. Which of (A)-(D) is not true in every rhombus?)



A. b'O{cf]6f las0f{x?sf] nDafO a/fa/ x'G5. (The two diagonals have equal length)

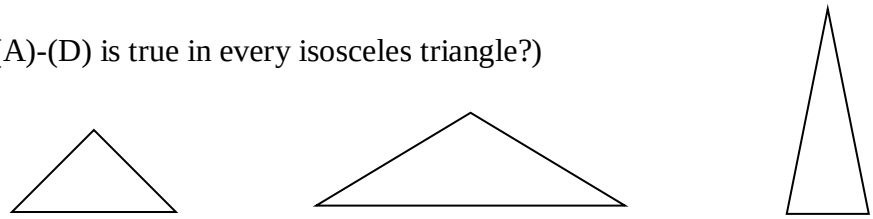
B. k|Tos las0f{n] ;dafx' rt'e'h{sf b'O{cf]6f sf]0fx?nfO ;dl4eflht u5{g. (Each diagonal bisects two angles of rhombus)

C. b'O{cf]6f las0f{x? cfk;df nDa x'G5g. (The two diagonals are perpendicular)

D. lakl/t e'hfx? a/fa/ x'G5g. (The opposite sides have same length)

E. (A)-(D) ;a} k|Tos ;dafx' rt'e'{hdf ;To x'G5g. (All of (A)-(D) are true in every rhombus)

9. ;dafx' lqe'h Pp6f o:tf] lqe'h xf], h;sf s'g} b'O{ e'hfx? a/fa/ x'G5g. oxFf tLgcf]6f pbfx/0fx? lbOPsf] 5. k|To]s ;dafx' lqe'hdf (A)-(D) s'g ;To xf]<(An isosceles triangle is a triangle with any two sides of equal length. Here are three example. Which of (A)-(D) is true in every isosceles triangle?)



A. tLgcf]6f e'hfx?sf] nDafO{ a/fa/ x'g'k5{. (The three sides must have the same length)

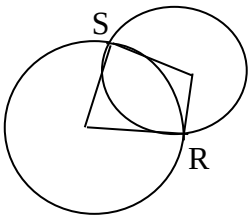
B. Pp6f e'hfsf] nDafO{ csf]{e'hfsf] nDafO{eGbf bf]Aa/ x'g'k5{. (One side must have twice the length of another side)

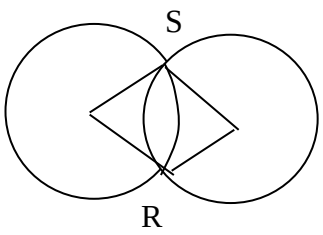
C. slDtdf b'O{ sf]0fsf] gfk a/fa/ x'g'k5{. (There must be at least two angles with the same measure)

D. a/fa/ gfksf sf]0fx? x'g'k5{. (The three angles must have the same length)

E. (A)-(D) s'g} ;To xf]Og. (None of (A)-(D) is not true for every isosceles triangle)

10. P / Q s]Gb|laGb' ePsf b'O{cf]6f lj[Qx?n] laGb' R / S df sf8\bf rt'e'{h PQRS ag]sf] 5, ofFxf @ cf]6f pbfx/0fx? 5g. (A)-(D) s'g ;wF} ;To x'b}g<(Two circle with center P and Qintersect at R and S to form a 4-sided figure PQRS, here are 2 examples. Which of (A)-(D) is not always true.)





A. PQRS a/fa/ nDafO ePsf b'O{cf]6f e'hfx? x'G5g. (PQRS will have two pairs of sides of equal length.)
B. PQRS a/fa/ ePsf slDtdf b'O{cf]6f sf]0fx? x'G5g. (PQRS will have at least two angles of equal measure.)
C. /]vf PQ / QR Pscfk;df nDa x'G5g. (The line PQ and QR will be perpendicular.)
D. P sf]0f / Q sf]0fsf] gfk a/fa/ x'G5. (Angle P and Q will have the same measure.)
E. (A)-(D) ;a} ;To 5g. (All of (A)-(D) is true.)

11. oxFf b'O{ ul0flto afSox? 5g. (Here are two statements.)

syg != (statement 1): lrq F Pp6f cfot xf]. (Figure F is a rectangle.)

syg @= (statement 2): lrq F Pp6f lqe'h xf]. (Figure F is a triangle.)

tnsfdWo s'g ;lx 5<(Which is correct?)

A. olb ! ;To xf] eg] @ klg ;To xf]. (If 1 is true, then 2 is true.)
B. olb ! ;To xf] eg] @ ´'6f] xf]. (If 1 is true, then 2 is false.)
C. ! / @ b'a} ;To x'g ;Sb}gg\. (1 and 2 can not both be true)
D. ! / @ b'a} ò'6f] x'g ;Sb}gg\. (1 and 2 can not both false.)
E. (A)-(D) s'g} klg ;To xf]Ogg\. (None of (A)-(D) is correct.)

12. oxfF b'O{cf]6f sygx? 5g. (Here are two statements)

syg (statement)S: ΔABCdf tLg}cf]6f e'hfx?sf] nDafO{ a/fa/ 5. (ΔABC has three equal sides)

syg(statement)T: ΔABCdf $\angle B$ / $\angle C$ sf] gfk a/fa/ 5. (In ΔABC, $\angle B$ and$\angle C$have the same measure.)

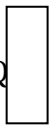
tnsf dWo s'g l7s 5<(Which is correct?)

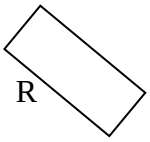
A. syg S / T b'a} ;To x'g ;Sb}gg\. (Statement S and T cannot both be true.)
B. olb S ;To eP T ;To 5. (If S is true, then T is true)
C. olb T ;To eP S ;To 5. (If T is true, then S is true)
D. olb S ò'6f] eP T ò'6f] 5. (If S is false, then T is false)
E. (A)-(D) s'g} klg ;To xf]Ogg\. (None of (A)-(D) is correct.)

13. tnsf dWo s'g s'g nfO{ cfot eGg ;lsG5<(Which of these can be called rectangle?)

A. ;a}nfO ;lsG5. (All can.)
B. Q dfq (Q only)
C. R dfq (R only)
D. P / Q dfq (P and Q only)
E. R / Q dfq (R and Q only)

P 

Q 

R 

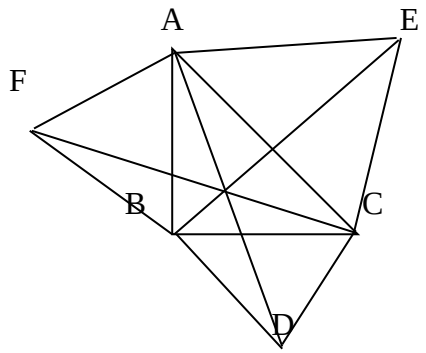
14.tnsf afSox?dWo] s'g ;To xf]<(Which is true?)

A. cfotsf ;a} u'0fx? ;a} ju{sf u'0fx? x'g. (All properties of rectangle are all properties of square.)
B. ju{sf ;a} u'0fx? cfotsf u'0fx? x'g. (All properties of square are properties of rectangle.)
C. cfotsf ;a} u'0fx? ;a} ;dfgfGt/ rt'e'{hsf u'0fx? x'g. (All properties of rectangle are all properties of parallelogram.)
D. ju{sf ;a} u'0fx? ;dfgfGt/ rt'e'{hsf u'0fx? x'g. (All properties of square are properties of parallelogram.)
E. (A)-(D) s'g} klg ;To xf]Ogg\. (None of (A)-(D) is correct.)

15. ;a} cfotdf s] x'G5 h'g ;dfgfGt/ rt'e'{hdf x'b}g. (What do all rectangle have that on parallelogram do not have.)

A. lakl/t e'hf a/fa/. (Opposite side equal.)
B. las0f{x? a/fa/. (Diagonals are equal.)
C. lakl/t e'hf ;dfgfGt/. (Opposite side are parallel.)
D. lakl/t sf]0f a/fa/. (Opposite angle equal.)
E. (A)-(D) s'g} klg ;To xf]Ogg\. (None of (A)-(D) is correct.)

16. ofFxf ;dsf]l0f lqe'h $\triangle ABC$ 5. lqe'h $\triangle ABC$;+u ;dafx' x'g]ul/ lqe'hx? lvlrPsf 5g. h;df AD BE / CF sf ;fòf laGb' 5. lgDg ;"rgfsf] cfwf/df tkfO tnsf] s'g lasNk 5fGg'x'G5<(Here are a right triangle ABC. Equilateral triangle ACE, ABF and BCD have been construct on side of ABC. From this information, one can prove that AD, BE and CF have a point in common. What would this proof tell you?



A. o; lqe'hsf] /rgfn] dfq eGg ;lsG5ls Ps laGb' ;fòf 5. (Only in this triangle drawn can we be sure that and have a point in common.)
B. ;a} geP/ s]lx dfq ;dsf]l0f lqe'hdf AD, BE / CF df ;fòf laGb' x'G5. (In some but not all right triangle, AD, BE and CF have a point common.)
C. h'g;'s} ;dsf]l0f lqe'hdf AD, BE / CF df ;fòf laGb' x'G5. (In any right triangle, AD, BE and CF have a point common.)
D. h'g;'s} lqe'hdf AD, BE / CF df ;fòf laGb' x'G5. (In any triangle, AD, BE and CF have a point common.)
E. h'g;'s} ;djfx' lqe'hdf AD, BE / CF df ;fòf laGb' x'G5. (In any equilateral triangle, AD, BE and CF have a point common.)

17. oxFf s'g} lrqsf tLg cf]6f u'0fx? 5g. (Here are three properties of s figure.)

u'0f (property) D: o;sf las0f{x?sf] nDafO a/fa/ 5. (It has diagonals of equal length.)

u'0f (property) S: of] au{ xf]. (It is a square.)

u'0f (property) R: of] cfot xf]. (It is a rectangle.)

s'g ;To 5<(Which is true)

A. D eP S x'G5 / S eP R x'G5. (D implies S which implies R.)
B. D eP R x'G5 / R eP S x'G5. (D implies R which implies S.)
C. S eP R x'G5 / R eP D x'G5. (S implies R which implies D.)
D. R eP D x'G5 / D eP S x'G5. (R implies D which implies S.)
E. R eP S x'G5 / S eP D x'G5. (R implies S which implies D.)

18. oxfF b'Ocf]6f sygx? lbOPsf] 5. (Here are given two statements.)

syg != (statement 1): olb s'g} lrq cfot xf] eg] o;sf las0f{ cfk;df ;dl2eflht xG5g\. (If a figure is rectangle, its diagonals bisect each other.)

syg @= (statement 2): olb s'g} lrqsf las0f{x? cfk;df ;dl4eflht 5 eg] Tof] cfot xf]. (If the diagonals of a figure bisect each other, the figure is rectangle.)

A. ! nfO{ k|dfl0ft ug{ @ nfO{ k|dfl0ft u/] k'U5. (To prove 1 is true, it is enough to prove 2 is true.)
B. @ nfO{ k|dfl0ft ug{ ! nfO{ k|dfl0ft u/] k'U5. (To prove 2 is true, it is enough to prove 1 is true.)
C. @ nfO{ k|dfl0ft ug{ las0f{x? ;dl4eflht x'g] op6f cfot km]nf k/] x'G5. (To prove 2 is true, it is enough to find one rectangle whose diagonals bisect each other.)
D. @ nfO{ unt ;flat ug{ las0f{x? ;dl4eflht x'g] cfot afx]ssf] lrq km]nfkf/] k'U5. To prove 2 is false, it is enough to find non rectangle whose diagonals bisect each other.)
E. (A)-(D) s'g} klg ;To xf]Ogg\. (None of (A)-(D) is correct.)

19. Hofldltdf (In geometry)

A. k|To]s kb÷zAbnfO{ kl/eflift ug{ ;lsG5 / k|To]s zTo sygnfO{ ;fFrf] xf] eg]/ k|dfl0ft ug{ ;lsG5. (Every term can be defined and every true statement can be proved true.)
B. k|To]s zAnnfO{ kl/eflift ug{ ;lsG5 t/ vf; s]lx sygx?nfO{ ;To x'g\ eg]/ dfGg cfjZos x'G5. (Every term can be defined but it is necessary to assume that certain statements are true.)
C. s]lx zAbnfO{ ckl/eflift zAbsf] ?kdf 5f8\g} kb{5 t/ k|To]s ;To syg rfFlx ;To x'g eg]/ k|dfl0ft ug{ ;lsG5. (Some terms must be left undefined but every true statement can be proved true.)
D. s]lx zAbx?nfO{ ckl/eflift zAbsf] ?kdf 5f]8\g} kb{5 / ;To x'g eg]/ dflgPsf s]lx sygx? x'g cfjZos 5. (Some terms must be left undefined and it is necessary to have one statements which are assumed true.)
E. (A)-(D) s'g} klg ;To xf]Ogg\. (None of (A)-(D) is correct.)

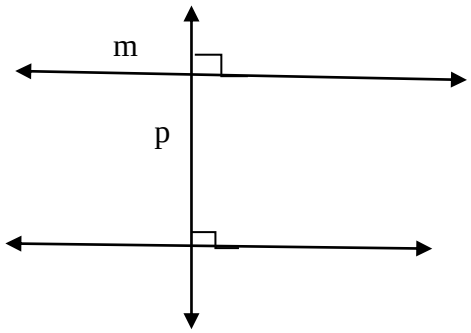
20. tn lbOPsf tLgcf]6f afSox? larf/k'j{s cWoog ug'{xf];\. (Examine these three sentences.)

I. plx /]vfx? ;+u nDa x'g] b'O{ /]vfx? ;dfgfGt/ x'G5g. (Two lines perpendicular to the same line are parallel.)
II. b'O{cf]6f ;dfgfGt/ /]vfx?dWo] Pp6f;+u nDax'g] /]vf csf]{ /]vf;+u klg nDa x'G5. (A line that is perpendicular to one of two parallel lines is perpendicular to the other.)
III. olb b]O{ j6f /]vfx? larsf[b'l/ a/fa/ 5 eg] lt /]vfx? ;dfgfGt/ x'G5g\. (If two lines are equidistant, then they are parallel.)

tnsf] lrqdf /]vfx? m / p Pscfk;df nDa 5g, To:t}ul/ /]vfx? n / p Pscfk;df nDa 5g. dfly lbOPsf jfSox? dWo] s'g rfFlx sf/0fn] /]vf m /]vf n ;+u ;dfgfGt/ x'G5<(In the figure

below, it is given that lines m and p are perpendicular and lines n and p are perpendiculars. Which of the above sentences could be a reason that line m be parallel to line n?)

A. I dfq (I only)
B. II dfq (II only)
C. III dfq (III only)
D. lst I oft II (Either I or II)
E. lst II oft III (Either II or III)



THE END

APPENDIX- C

LEST OF SCHOOL SELECTED FOR STUDY

Secondary schools of Glyan Municipality

1) Sarbajanik Ma Vi- *Malunga*
2) Sibalaya Ma Vi- *Balamguth*i
3) Adarsa Ebs Ma Vi-*Jagatradev*i
4) Bhanu Bhakta Acharya Ma Vi-*Galyan Bazar*

5)Chirag Ebs Ma Vi-*Galyan Bazar*

6)Galyan Bhupu Sainik Ebs Ma Vi-*Galyan*

7)Kalika Ma Vi -*Neuwakharka*

8)Shishukalyan Ma Vi-*Neuwakharka*

9)Satya Shila Ma Vi-*Syalbas*

10)Narodaya Ma Vi-*Pindikhola*

11)Rastriya Ma Vi-*Pelakot*

12)Nepal Rastriya Ma Vi -*Pelakot*

13)Mahendra Darsan Ma Vi-*Tindobate*

14)Gyanodaya Ma Vi-*Gaumukha*

15)Gandaki Ma Vi-*Pakwadi*

16)National Goldren Future Ebs MA vi-*Tindobate*

17)Janaki Ma Vi-*Amelayur*

18)Pakawadi Bhanjyang Ma Vi-*Pakawadi*

19)Bajre Bhanjyang Ma Vi-*Bajre*

20)Galkot Ma Vi-*T.Bhanjyang*

APPENDIX-D

To check reliability of research tools (VHGT), researcher administered test and re-test among 25 students of Shisu Kalyan Secondary school. Researcher used test-retest method to find reliability and calculated correlations coefficient (ρ) using by Spearman's Rank correlation coefficient.

Test X	Retest Y	Rank of test x	Rank of retest y	d=x-y	d^2
10	11	18	23	-5	25
7	7	5.5	6	-0.5	0.25
10	10	18	17	1	1
12	12	25	25	0	0
7	6	5.5	2.5	3	9
9	10	13.5	17	-3.5	12.25
10	10	18	17	1	1
7	6	5.5	2.5	3	9
10	10	18	17	1	1
11	10	22.5	17	5.5	30.25
6	6	1.5	2.5	-1	1
10	11	18	23	-5	25
7	8	5.5	8.5	-3	9
11	10	22.5	17	5.5	30.25
8	10	10	17	-7	49
6	6	1.5	2.5	-1	1
9	10	13.5	17	-3.5	12.25
9	9	13.5	11	2.5	6.25

7	7	5.5	6	-0.5	0.25
11	10	22.5	17	5.5	30.25
8	9	10	11	-1	1
7	8	5.5	8.5	-3	9
9	7	13.5	6	7.5	56.25
11	11	22.5	23	-0.5	0.25
8	9	10	11	-1	1
					Σd^2 =320.5

m_1=2, m_2=6, m_3=3, m_4=4, m_5=5, m_6=4, m_7=4, m_8=3, m_9=2, m_{10}=3, m_{11}=9, m_{12}=3

$\rho = 1 - \frac{6[\sum d^2 + \frac{m(m^2-1)}{12}}{n(n^2-1)}$, Where m is the number of times that an item repeated.

$$\rho = 1 - \frac{6[320.5 + \frac{2.3}{12} + \frac{6.35}{12} + \frac{3.8}{12} + \frac{4.15}{12} + \frac{5.24}{12} + \frac{4.15}{12} + \frac{4.15}{12} + \frac{3.8}{12} + \frac{2.3}{12} + \frac{3.8}{12} + \frac{9.80}{12} + \frac{3.8}{12}]}{25.624}$$

$$\rho = 1 - \frac{2592}{15600}$$

$$\rho = 0.833$$

APPENDIX-E

Students' Achievement on VHGT of different four schools in Pre-Test

Naro Daya Secondary school.

S.N	van Hiele levels					Total Marks	Remarks
	L_0	L_1	L_2	L_3	L_4		
1	4	3	1	0	0	8	
2	4	4	2	1	0	11	
3	4	2	3	1	0	10	
4	4	1	1	0	0	6	
5	3	3	3	0	0	9	
6	2	3	2	1	0	8	
7	5	3	1	0	0	9	
8	4	3	2	1	0	10	
9	4	1	1	0	0	6	
10	5	2	1	0	0	8	
11	5	3	1	0	0	9	
12	5	1	1	0	0	7	
13	3	3	1	0	0	7	
14	4	0	0	0	0	4	
15	4	3	3	1	0	11	
16	3	2	1	3	0	9	
17	2	2	0	0	0	4	
18	3	3	3	1	0	10	
19	5	3	1	0	0	9	
20	5	2	1	0	0	8	
21	2	1	1	0	0	4	
22	5	2	2	2	0	11	
23	5	1	1	0	0	7	
24	2	1	0	0	0	3	
25	3	3	3	1	0	10	

Satya Shila Secondary school.

S.N	van Hiele levels					Total Marks	Remarks
	L_0	L_1	L_2	L_3	L_4		
1	4	2	3	1	0	14	
2	3	3	0	0	0	6	
3	4	3	1	0	0	8	
4	4	2	1	0	0	7	
5	5	2	1	0	0	8	
6	4	3	3	0	0	10	
7	5	2	1	0	0	8	
8	4	3	2	1	0	10	
9	4	4	3	1	0	12	
10	3	3	3	0	0	9	
11	5	2	1	0	0	8	
12	3	3	1	0	0	7	
13	5	2	1	0	0	8	
14	2	1	1	0	0	4	
15	3	3	1	0	0	7	
16	3	2	3	0	0	8	
17	4	1	1	0	0	6	
18	5	2	1	0	0	8	
19	4	2	1	0	0	8	
20	4	2	0	0	0	6	
21	3	3	1	0	0	7	
22	2	1	0	0	0	3	
23	2	2	1	0	0	5	
24	4	2	0	0	0	6	
25	5	3	1	0	0	9	

Rastriya Secondary school

S.N	van Hiele levels					Total Marks	Remarks
	L_0	L_1	L_2	L_3	L_4		
1	4	3	2	1	0	10	
2	4	3	2	3	0	11	
3	5	2	2	0	0	9	
4	4	3	2	1	0	10	
5	5	3	1	0	0	9	
6	4	3	2	0	0	9	
7	3	2	1	0	0	6	
8	4	3	2	0	0	9	
9	3	2	1	0	0	6	
10	4	2	1	1	0	8	
11	4	3	1	1	0	9	
12	3	2	1	1	0	7	
13	4	2	1	0	0	7	
14	3	1	0	0	0	4	
15	4	3	3	0	0	10	
16	4	3	2	0	0	9	
17	2	1	0	1	0	4	
18	4	3	2	0	0	9	
19	4	2	3	0	0	9	
20	4	2	2	1	0	9	
21	3	0	1	0	0	4	
22	4	2	3	1	0	10	
23	4	3	1	3	0	11	
24	3	2	1	1	0	7	
25	4	3	3	1	0	11	

Bhanu Bhakta Secondary school

S.N	van Hiele levels					Total Marks	Remarks
	L_0	L_1	L_2	L_3	L_4		
1	4	3	3	1	0	11	
2	5	4	2	1	0	12	
3	5	4	3	1	0	13	
4	4	3	1	0	0	8	
5	4	4	2	1	0	11	
6	5	2	3	1	0	11	
7	4	3	3	3	0	13	
8	5	3	3	1	0	12	
9	5	3	3	2	0	13	
10	4	1	0	0	0	5	
11	4	4	2	3	0	13	
12	3	0	0	0	0	3	
13	4	3	2	1	0	10	
14	4	3	2	0	0	9	
15	5	3	1	0	0	9	
16	4	3	1	0	0	8	
17	4	4	2	3	0	13	
18	3	2	1	0	0	6	
19	4	1	1	0	0	6	
20	4	3	3	0	0	10	
21	4	1	2	0	0	7	
22	4	3	1	0	0	8	
23	4	3	0	0	0	7	
24	4	3	2	0	0	8	
25	4	2	1	0	0	7	

APPENDIX-F

Calculation while determined the Experimental and Control group

$n_1 = n_2 = 25,$

$\overline{x}_1 = 7.92, \quad \overline{x}_2 = 7.48$

$s_1^2 = 5.2736, \quad s_2^2 = 4.4096$

$f = \frac{s_1^2}{s_2^2} = \frac{5.2736}{4.4096} = 1.19$

Hence, computed f value f = 1.19 $<$ tablulated f value f = 1.98 ($f_{0.05,24,24}$). Therefore, H_0 is accepted. Thus, there is no significance difference between achievement of two schools (Narodaya and Satya Shila) in VHGT.

Appendix-G

Class observation note ……..

Date ……..

School name …….

Note keeping

- Students activities
    I. Students Participation
    II. Question answer
    III. Students side talking
    IV. Feeling the classroom in teaching
- Van Hiele approach teaching phase
    I. Feeling problem and solving
    II. Collaborative discussion
    III. Students motivation
- Shared personal practice
    I. Shared outcomes of practices
    II. Mentoring and coaching

Appendix-H

Interviews for the Teachers and Students

Denotes the symbols R: Researcher and S: Student.

1. R: Do you think that van Hiele approach in teaching geometry effective while learning geometry?

   S: ……

2. R:What you like van Hiele approach in teaching geometry?

   S: …….

3. R: Do you think Van Hiele approach in teaching phases of geometry more enjoyable and memorable then traditional method of teaching geometry?

   S: …….

4. R: What are the get by using Van Hiele approach teaching geometry?

   S: ……

5. R: What are the different you get teaching geometry by using Van Hiele approach or not?

   S: …….

6. R: Do you think that all school teacher in geometry teaching using by van Hiele approach?

   S: …….

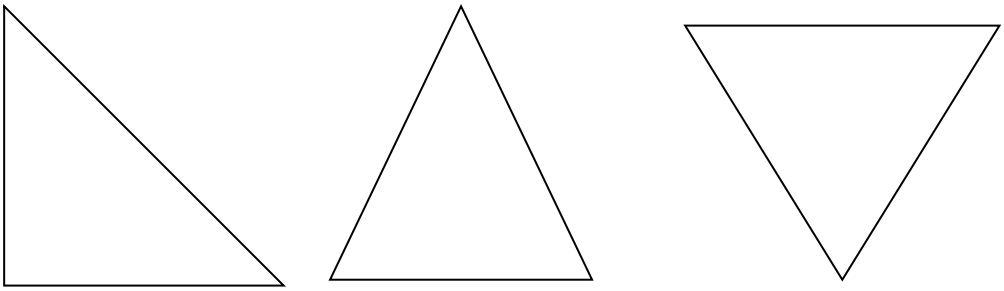
APPENDIX-H

Some Teaching Episodes which used in Teaching Experimental Group

Teaching episode-10

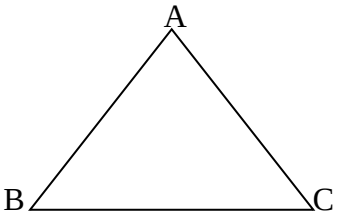
- Proof of the sum of interior angles of triangle is 180^0.

Information/Inquiry: In this stage students learn about the nature of geometric objects

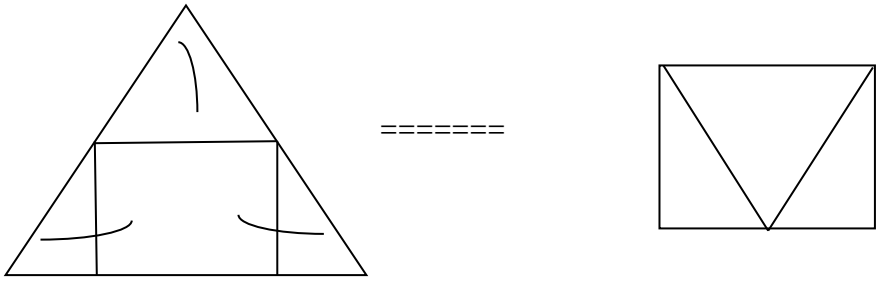


Students say that all three are triangles, each of them have three angles some of acute, some of abuse and some right angle. And they think about side of these triangles also.

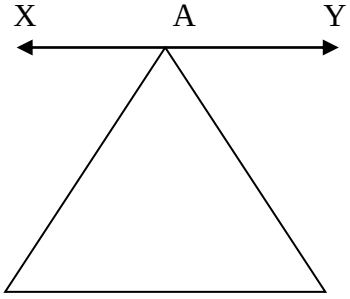
Guided Orientation: During this phase while students doing their short activities with set of outcomes like: measuring, folding and unfolding, or geometric games, teacher provides appropriate activities.



Students measure the three angles A, B and C using geometric instruments and they find the sum of these angles are 180 degrees.



Students fold triangle as above then they find that all three angles of this triangle lie on a point of straight line with measure 180 degrees.



Researcher recall the students about alternative angle and correspondence angle. And provide

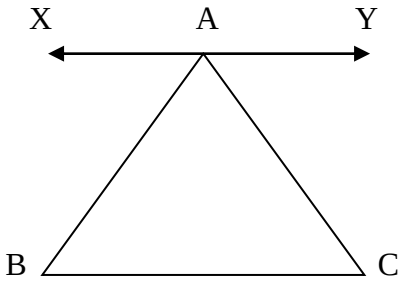
information that XY parallel to BC. Students react that $\measuredangle XAY = \measuredangle ABC \; and \; \measuredangle YAC = \measuredangle ACB$ and get a conclusion.

B C

Explanation: In this stage students try to describe their learning of new concept in their own words. In this phase, students start to express their conclusion and findings with their other classmates and teachers.

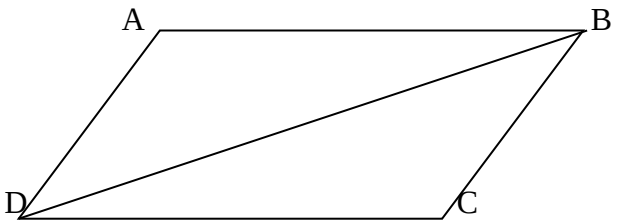
Free Orientation: In this phase geometrical tasks that appeal to numerous ways is presented to the students who decide how to go about accomplishing these tasks.

Students able to justify that $\measuredangle A + \measuredangle B + \measuredangle C = 180^0$ with the following discussion.



Statements	Reasons
1 $\measuredangle XAY + \measuredangle BAC + \measuredangle YAC = 180^0$	1 ????
2 $\measuredangle ? = \measuredangle ?$	2 Alternative angles on XY ∥ BC
3 $\measuredangle YAC = \measuredangle ACB$	3 ????
4 $\measuredangle ? + \measuredangle ? + \measuredangle ? = 180^0$	4 From above statements.

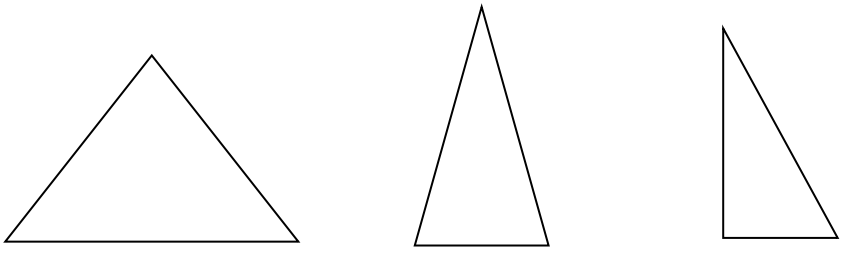
Integration: In this stage students summarize completed tasks and overview whatever they have learned to develop a new network of concepts. Students can develop a new knowledge that the sum of interior angles of quadrilateral is $360^0(180^0 + 180^0)$ because why it has two triangles when separated by a diagonal.



Teaching episode-11

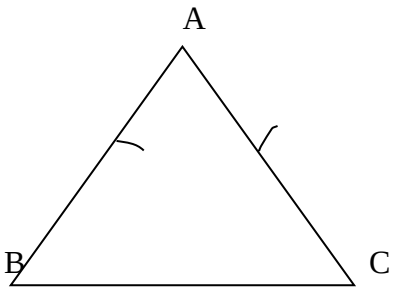
- Proof of the base angles of isosceles triangle are equal in measure.

Information/Inquiry:

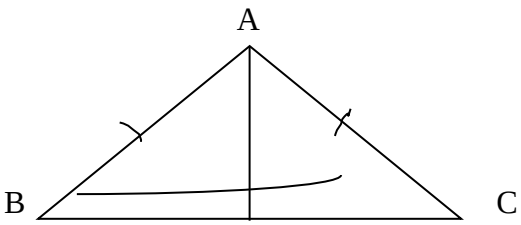


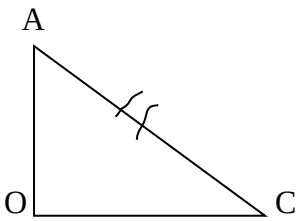
Students collect information from above three triangles that first triangle has three equal sides, second triangle has only two equal sides and third triangle has none of each side equal.

Guided Orientation:



Students measure two equal sides AB and AC after then they measure their base angles ∡B and $\angle C$ by using geometric instruments. And they get a conclusion.



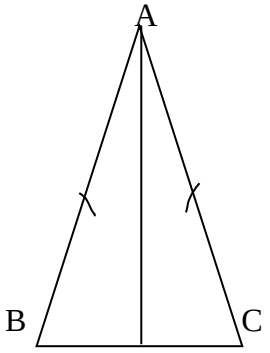


Students fold triangle as above then corner B lies on corner A congruently, two base angle overlapping to each other and clear about the objective of lesion.

Explanation: Students describe a concept which has been developed from above orientation in classroom. "The base angles of isosceles triangle are equal"

Free Orientation: Students able to justify $\measuredangle B = \measuredangle C$ making by a figure which is necessary to prove this statement. And discussion as followings.

Take a isosceles triangle $\triangle ABC$ construct a line AO such that $\measuredangle BAO = \measuredangle CAO$.



Statements	reasons
1. In triangle ABO and ACO	1.
(i) AO=AO	(i) ???
(ii) $\measuredangle BAO = \measuredangle$?	(ii) according to construction

(iii)AB=??	(iii) given us
2.$\Delta ABO \cong \Delta ACO$	2. which congruence property?
3.$\measuredangle B = \measuredangle C$	3.???

Integration: Students can develop this geometric statement by R.H.S property construct by AO ⊥ BC

They also can collect the fact and reasons to prove its vice versa theorem, "If any triangle has two equal angles then the length of opposite side is also equal."

APPENDIX-J

Students' Achievement on VHGT of different two groups in Post-Test.

Experimental group.

S.N	van Hiele levels					Total Marks	Remarks
	L_0	L_1	L_2	L_3	L_4		
1	5	4	3	3	0	15	
2	4	3	3	1	0	11	
3	5	3	2	1	0	11	
4	5	3	2	1	0	11	
5	5	3	3	3	0	14	
6	5	3	3	1	0	12	
7	5	3	2	1	0	11	
8	5	3	3	2	0	13	
9	5	5	2	3	0	15	
10	4	4	3	1	0	12	
11	5	3	2	3	0	13	
12	4	3	3	1	0	11	
13	5	3	3	1	0	12	
14	5	3	3	1	0	12	
15	4	3	3	1	0	11	
16	4	3	3	2	0	12	
17	5	2	2	1	0	10	
18	5	3	2	2	0	12	
19	5	3	3	0	0	11	
20	5	3	1	2	0	11	
21	4	3	1	2	0	10	
22	4	3	2	1	0	10	
23	4	3	3	0	0	10	
24	5	3	1	2	0	11	
25	5	4	3	3	0	15	

Control group

S.N	van Hiele levels					Total Marks	Remarks
	L_0	L_1	L_2	L_3	L_4		
1	5	3	2	0	0	10	
2	5	4	3	1	0	13	
3	5	2	3	1	0	11	
4	5	2	2	0	0	9	
5	4	3	3	1	0	11	
6	3	3	2	1	0	9	
7	5	3	2	1	0	11	
8	5	4	2	1	0	12	
9	4	3	2	0	0	9	
10	5	3	1	0	0	9	
11	5	2	2	2	0	11	
12	5	2	1	1	0	9	
13	4	2	3	1	0	10	
14	4	2	1	1	0	8	
15	5	2	3	3	0	13	
16	4	2	2	3	0	11	
17	4	2	1	0	0	7	
18	5	2	3	1	0	11	
19	5	2	3	1	0	11	
20	5	2	2	1	0	10	
21	4	2	1	0	0	7	
22	5	2	3	2	0	12	
23	5	2	1	0	0	8	
24	2	2	2	0	0	6	
25	4	2	3	2	0	11	

APPENDIX-K

Calculation while determined the effectiveness of VH geometric thought in teaching geometry.

$n_1 = n_2 = 25,$

$\overline{x}_2 = 9.96, \quad \overline{x}_1 = 11.84$

$s_2^2 = 3.2384 \quad s_1^2 = 2.28$

Now, $S_p^2 = \frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}$

$$= \frac{24 \text{ x } 3.2384 + \ 24 \text{ x } 2.28}{25 + 25 - 2}$$

= 2.7592

Since, $S_p = 1.661$

Here, $t = \frac{(\overline{x}_1-\overline{x}_2)-d_0}{S_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} = \frac{11.84-9.96}{1.661\sqrt{\frac{1}{25}+\frac{1}{25}}} = 4.001$

Hence, computed t value of t = 4.001 >table value of t = 1.96 (0.05 label of significance in two tail test). Therefore, H_0 is rejected. Thus, there is significance difference between achievement of experimental and control group. Hence it is concluded that the average achievement of VHGT of experimental group is higher than the achievement of VHGT of control group.