

Chapter-I

INTRODUCTION

Background of the Study

The Van Hiele approach of teaching geometry is new method and more effective to that geometry in the classroom. This approach is the 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. Most of the educational researches are continuously suggesting to use Van Hiele approach in teaching geometry. The new learning concept like assessing students performance using Van Hiele approach in teaching geometry at lower 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 lower secondary level.

The Van Hiele approach has been applied in curriculum of many country like, UK, and USA (Clement 2004). In the late 1950's Pierre and Dena Van Hiele (a Dutch husband and wife team) introduced their development model of geometric thinking. They believed that students have various level of cognition. And they expressed the properties and relationship of geometric concepts are related to the those various levels. The five levels of geometric thinking (0 level: visualization, 1 level: analysis, 2 level: informal deduction, 3 level: deduction, and 4 level: axiomatic/rigor) can be varied according to the as of students. As students develop the cognitive skills necessary to master one level then they progress to the next. For the classroom teacher, it is important that to assess at what level students are functioning when they seem passive in his/ her class. Van Hiele believes that students difficulty in

mathematics normal and particular in geometry is caused largely by teacher's failure to deliver instruction that is appropriate to their thinking level.

Geometry is one of the most applicable and daily useful branches of mathematics. It includes enormous range of ideas and can be viewed in many different ways. It has been interlaced with many others subjects and different views of human activities. The concept of geometry in mathematics was developed by 'Kelly and Ladd', (1986, p. 5-15) in twenty-two or twenty three ago. This time formally discovered the geometry by 'Euclid'. According the Euclid the word 'geometry' is derived from the Greek words Geo + Metry (C. Wallace and F. west). As this word Geo means 'Earth' and 'Metry' means measurement. So the whole words Geometry means the measurement of the earth or earthly things.

Geometry is one of the understanding parts of mathematics. The shape, size and other properties of figures and the nature of space are the measurement of geometry. It is the branch of mathematics that deals with the measurements and relationship of line, angle, surface, and solid. The measurement of line, angle, surface area etc. is particular object or shape. Euclidean geometry is concerned with the axiomatic system of study of polygons, conic section, spheres, polyhedral and related geometric objects in two and three dimensions (Wallace and West, 1998 "Second edition").

According to historical evidence, geometry was developed faster than other mathematics. But nowadays, it is regarded as one of the branch of mathematics. It is the oldest intellectual pursuits of man. The origin of geometry is the earliest Babylonia and Egypt. It is essential and empirical science cultivated solely for its utility with the art of practical measurement and logical subject, so that the Plato advocated that every students of law must study geometry because law is also logical subject.

Mathematics has been taught as a compulsory subject at all levels of school system in Nepal. Besides compulsory mathematics optional mathematics is also offered to willing and worthy students. In both subject area geometry is taught separately as an important part of the whole school mathematics curriculum. Thus, geometry is considered as an important component of school mathematics. There is a vital role of teacher to show all these importance of geometry to the students in their teaching. Moreover, geometry has covered 30% area in mathematics curriculum according to 'N C F 2063'. So, the geometry is the most important part of mathematics to the school level curriculum.

In the new area of research the lower secondary level is basic level of student of geometry. So, in this level students geometry should be in meaningful learning of mathematics. But in this area of educational researches in the decades shows that achievement of geometry is very poor. Why? So, many of the problems of different profession and discipline are related to geometry. This attitude towards geometry may be due to the lack of appropriate teaching methods. In the context of Nepal there are curriculum, instructional materials, text books, teacher guides to conduct the regular teaching activities in the classroom and teacher training package for improving the achievement of the students. In spite of these efforts significant achievement is not found. It implies that there is need to suggest new method of learning management and teaching for geometry based on research and experiment.

These are the many problems and issues of geometry teaching and improve an achievement of students. Is Van Hiele approach of teaching geometry at lower secondary useful to teach geometry for improving achievement, what is the students understanding of geometry? Also, the lower secondary level geometry teacher, how can easily understanding geometry teaching, how can improve the achievement of

students in geometry, this is possible too! So the researcher in this study, the focus points are to improve achievement and understanding thinking level. Also the researcher tried to find out can Van Hiele approach be effect to teach geometry at lower secondary level.

Statement of the Problems

Geometry is a base for thinking construction and practical subject. But for Nepali context of this class for teaching traditional approach such limit for chalk and duster. It is a modern society for the geometry class is many modern materials and learning by doing approach fallow up. So, the geometry to find the student low achievement, not meaningful understanding students in geometry teaching learning. How maintained the main problems of classroom in the geometry teaching.

In the issues of ineffectiveness of traditional method of geometry teaching and 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 lower secondary level (Grade seven students). This study was an experimental study. The only one parameter of effectiveness used in this study is the level of learning achievement of the student intended to answer the following question.

- Is Van Hiele approach of teaching more appropriate in classroom than traditional approach of teaching geometry at lower secondary school students at Grade VII?
- Do the students feel easy in learning geometry using Van Hiele approach?
- Are there any difference between Van Hiele approach and traditional approach?

Objective of the Study

The objective of the study where,

- To compare the Van Hiele approach and traditional approach of teaching geometry at Grade VII students.
- To find the attitude of the Van Hiele approach of teaching geometry at Grade VII students'.

Hypothesis of the Study

- **Research Hypotheses**

The research hypotheses formulated for the studied where as follows: There is no significance difference in the achievements in geometry teaching at grade seven students through the Van Hiele approach and traditional approach of teaching.

- **Statistical Hypothesis**

$$H_0: \mu_1 = \mu_2 \text{ (null hypothesis)}$$

$$H_1: \mu_1 \neq \mu_2 \text{ (alternative hypothesis)}$$

Where, μ_1 and μ_2 are the mean score of the students taught by using the Van-Hiele approach and traditional approach in geometry respectively.

Significance of the Study

In the experiences of school mathematics teachers many students encounter difficulty in school geometry. The reason behind this fact might be the lack of sufficient experiences in students in geometry thinking as perquisite from lower 'levels'. Therefore in this study, the researcher has focused on the effectiveness of Van Hiele phase of teaching Geometry at lower secondary level students.

Method of teaching geometry in school at present is not really appreciable. Most of the students are found negative to learning geometry. The Van-Hiele phase of

teaching model is new for classroom implication. This model is most important which has been found useful in assessing students thinking in geometry. They feel that learning of geometry is learning to prove geometry propositions and proving propositions is difficult tasks. Equally, most of the teacher in school do not like to bother to adopt new method of teaching, because it becomes challenging them.

In nutshell, this study has significance in the following:

- This study experimentally verified and justified the effectiveness of Van Hiele approach in geometry teaching. So, teacher can use it following the strategies as used in the experimental phase. It may provide one more instance to establish a new method of teaching in the Nepalese context.
- The result of the study has given the mental development level of the grade seven students. This could be great information to curriculum designer and even the textbook writers, so that they could organize and sequence their contents according to the mental development level in geometry.

Delimitation of the Study

The study was limited in the following aspects:

- The study is confined within Vidyapur Village.
- This study is conducted only for the area of geometry specially Triangle, Quadrilateral, and Polygon of grade seven students.
- This study based on the only one government school students at grade seven.
- This study based on Van Hiele level of approach and traditional teaching method of geometry.

- This study is conducted at the Janata Higher Secondary School Vidyapur-4, Surkhet.

Definition of Terms

Van Hiele Approach (VHA): VHA is the new method of teaching geometry analysis of the achievement in lower secondary school geometry test, which was used by Van Hiele approach (phases of teaching geometry) for the student to find their achievement.

Traditional approach: Traditional approach is the teaching method for teacher center method of geometry teaching in lower secondary school. Which was used this approach, and find the achievement in geometry at grade seven students.

Achievement: The achievement on this study is defined in terms of scores obtained by the learning in the mathematics achievement test constructed by the researcher.

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 achievement test.

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 traditional method was considered as control group.

Variable: A variable is an important concept to study in research methodology. It plays a significant 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 measures to determine the effect of the independent variable. Achievement score in the test of mathematics is the dependent variable in this study.

Independent Variable: Independent variable is the major variable which the researcher hopes to investigate. Method of teaching is the independent variable in this study.

Chapter-II

REVIEW OF THE RELATED LITERATURE

Review of literature is an essential part of all studies. It is a 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 purpose of review of related literature is to develop some expertise in one's area to see what new contributions can be made and to receive some idea from developing research design.

Empirical Literature Review

In this study, three terms are in focus: student achievement, effectiveness of Van Hiele approach, thinking level of geometry. These three aspects are briefly reviewed and captured based on literature concern.

Teaching is a mass phenomenon but learning is a individualized process. Therefore student achievement must be related to teacher, teaching materials and using method. Also understanding level of student is most important to know teacher teaching at classroom.

The researcher tried to find out the literature on the topic that related to problems faced by mathematics students in learning geometry, number of books, paper, research reports and book list can be found that concern with curriculum instructional materials, method, and so on. Some of the literatures reviewed by researchers which are related to the present study are discussed below:

A study carried out by **Lamsal, (2005)** entitled "A study on the effectiveness of Van Hiele approach in teaching geometry at lower secondary level", to analyse and exploring the effectiveness of the 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 Syanja district. He conducted this study as experimental on the 49 pupils of the sample with the help of teaching episode as a research tool using by achievement test. The achievement students are analysed statistically by using Mean, Standard deviation, t-test at 0.05 levels of significance. This study the researcher conclude that Van Hiele approach is more effectiveness in teaching geometry at grade eight students the conventional approach. This study supported that the Van Hiele approach in teaching geometry is more applicable, effectiveness and to support improve the achievement of students in geometry.

A study carried out by **Gyawaly, (2009)** entitled “Effectiveness of Van Hiele approach in teaching geometry at the secondary level” to analyse the effectiveness of Van Hiele approach in teaching geometry at secondary level student. The data were collected from Nawalparasi district using by experimental research design. In this study researcher selected the sample consisting of forty students purposively from public school. The researcher taught the experimental group by using Van Hiele approach and the control group by conventional approach. An achievement test was main tools of the study. The achievement of student are analysed statistically by using Mean, Standard deviation, t-test at 0.05 levels of significance. Thus, the researcher concluded that Van Hiele approach is effective in teaching geometry at secondary level students than the conventional approach. To supported the research an effectiveness of Van Hiele approach in teaching geometry, to help the improve achievement students in geometry.

A study carried out by **Ghimere, (2010)** entitled “A study on the achievement of grade VIII students in geometry teaching at Lamjung district” to analyse achievement of grade VIII students in geometry, and also to compare the achievement of students studying in private boarding school with public school on geometry. The

data were collected from conducted with the researcher randomly selected 5 public and private boarding schools in Lamjung distinct, using survey design of students achievement in geometry. An achievement test was main tools of the study. The achievement of students, are analysed statistically by using Mean, Standard deviation, t-test at 0.05 levels of significance. The obtain information result shoes that there is low achievement of student geometry in Lanjung distinct, and there is significance difference between the achievement of students studying in private schools and public school geometry. The researcher conclude that the low achievement of students in geometry and the achievement of student to improve the private school that the public school. In this research support the inform students, low achievement in geometry.

A study carried out by **Achrya, (2011)** entitled “A study on Van Hiele level of thinking of primary school students in geometry” to analyse the thinking level of geometry students at primary level and also analysis perform in geometry in this level boys and girls student. The data were collected from Baglung distinct all grade five students and taking sample 260 students using survey design of thinking level in geometry. These 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 and 2 respectively, and the boys can perform better than the girls in geometry. In this study supported the Van Hiele level of thinking help the students to understand geometric ideas and it helps the students to motivate and apply the known geometrical concepts in unfamiliar condition.

A study carried out by **Oli, (2011)** did a thesis title “Students Van Hiele level of geometry through and its relationship to their achievement in mathematics” to analyse and exploring the Van Hiele levels of geometric thinking of grade X students

and also explore the correlation between the Van Hiele level and mathematics achievement of the students. The researcher using by survey design in this studies conducted Salyan distinct. The population was study grade X- 230 students and 6 mathematics teachers from the selected schools. The sample of the study six school where selected from the district by using stratified random sampling method. Adapted version of Van Hiele geometry achievement test was used as main tools for the data collection. And the finding of this study of the result for this study indicated that many of students who participated in the research have a work conceptual understanding of geometric concepts 52.61%, 20%, 11%, and 0.01% of the total students where at the level 0 (visualization), level 1(Analysis), level 2(Informal deduction), level 3(Deduction) respectively. No students were found to be thinking at level 4 (Regor). Also, the score obtained by students on VHGT and SMS where correlated and correlation coefficient was found to be 0.85. This result was a significant strong positive correlation between the advancement of the VHLT of understanding geometry and achievement. In this study to supported what student level of thinking geometry and also to support the relation between Van Hiele level of thinking in geometry and its achievement.

Also a study carried out by **Oli, (2013)** entitled “Van Hiele level of geometry taught and mathematics achievement of student” to analyses and exploring the Van Hiele level of geometric through of secondary level students and the relationship between mathematics achievement and Van Hiele level of geometric through in this study. The researcher using by survey design in this study conducted Rukum distinct. The population was study grade x-52 schools and each student, in the Rukum distinct. Van Hiele geometry achievement test and school mathematics test was used as a main tools for the data collection. The finding of this study of the result of the student who

participated in the research have a work conceptual understanding of geometry concepts 28.67%, 26.67%, 20.67%, and 8.67% of total students where at the level 0, level 1, level 2, and level 3 respectively. No student where found to be thinking at level 4. Furthermore and interview schedule for teacher was development to get their reflection about VHGT. The scores obtained by students on VHGT and SMT where correlated and correlation coefficient was found to be 0.68. The results indicated that there was a positive correlation between Van Hiele level of geometric through and mathematics achievement. Also supported that study the positive relation Van Hiele level of thinking in geometry and its achievement of student.

From the literature reviewed, to support the in this my study effectiveness of Van Hiele approach. Also from the above review of the study related literature shows that no investigation was neither directly related to the study of effectiveness of Van Hiele approach in teaching geometry in the context of Nepal, nor any such study had been conducted so far. The total six reviews in this study these two reviews related to effectiveness of Van Hiele approach, also three reviews are related to thinking level of geometry and another review is related to students achievement in geometry. Efforts have been made to inform teacher of the theory as well as suggest strategies for how it might impact classroom instruction. It is found that Van Hiele approach supported the meaningful and produced the achievement in geometry teaching.

Theoretical Literature Review of Study

The Van Hiele theory of geometric through describes the different levels of understanding 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. Geometry instructions should be designed with these levels in mind (Choi-koh 1999). The Van Hiele model for the

theory of geometry through consists of five levels (see table 1) (Burger and Shaughnessy 1986).

Table: 1		
The Van Hiele theory of geometric through describes the different levels of understanding through which student's progress when learning geometry.		
Van Hiele theory of geometry through		
Level	Description	Ability of students
1	Visual	Describes shapes on the basis of their appearance.
2	Analysis	Describes shapes on the basis of their properties.
3	Abstraction	Recognizes the importance of properties and the relationships among them which assist students in logically ordering the properties of the shapes.
4	Deduction	Attains logical reasoning ability and proves theorems deductively
5	Regor	Establishes and analyzes theorems in different postulation systems.

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 (Clements 2003, p. 152). Progression from one level to the next is facilitated through strategically planned instruction (Van Hiele Geldof 1984, Clement 2003). During early elementary school students tend to move from level 1 to level 2. For example at level 1 students name all shapes that look like boxes as rectangles. Then at level 2, students sharpen the ability to describe attributes, such as characterizing a rectangle as a flat shape with four sides and four corners. Also at level 2, the rectangle is described as a quadrilateral with four sides, four right angles and with congruent and parallel opposite sides. The Van Hiele suggested that students

develop a deep understanding of all geometric concepts through a similar progression from level 1 to level 5. Thus effective geometry teaching guides students through each of these levels. According to the Van Hiele model the five phase support students as they progress through the levels of geometric through (See table 2). In this article we describe a sequence of activities that we developed to capitalize in and enhance elementary school student geometric thinking using this five phase framework (Howse and Howse 2014, vol. 21, Issue 5).

Table-1	
Five phases of learning support students as they progress through levels of geometric through.	
Framework of the Van Hiele phases of learning.	
Phases	Descriptions
Information	Students develop vocabulary and concept for a particular task. The teacher assesses students interpret/ reasoning and determines how to move forward with future tasks.
Directed orientation	Students actively engage in teacher directed tasks. They work with the development from the previous stage to gain an understanding of them as well as the connections among them.
Explication	Students are given the opportunity to verbal their understanding. The teacher leads the discussion.
Free orientation	Students are challenged with tasks that are more complex and discover their own ways of completing each task.
Integration	Students summarize what they have learned creating an overview of the concept at hand.

Also the Van Hiele developing the phase of teaching geometric describe as following teaching model.

Pace-1: Information and identification of geometrical shapes: In this phase, students become acquainted with the 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.

Phase -2: Directed orientation: In this phase, students become acquainted with the geometric objects from which geometrical idea are abstracted. The researcher role is to direct student's activity by guiding them in diagrammatically explorations- 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.

Phase-3: Explication about figures: Students become conscious of the relation and being to elaborate on their intuitive knowledge. Thus, in this phase children become explicitly aware of their geometric conceptualizations, in their own language for the subject matter, teacher's role in this phase is to introduce the relevant mathematical terminology.

Phase-4: Free orientations: Children solve problems whose solution requires the synthesis and utilization of the concepts and relations previously elaborated. They learn to orient themselves within the "network of relations" and to apply the relationships 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 these problems and their solution and to introduce teems, concepts and relevant problem-solving processes as needed.

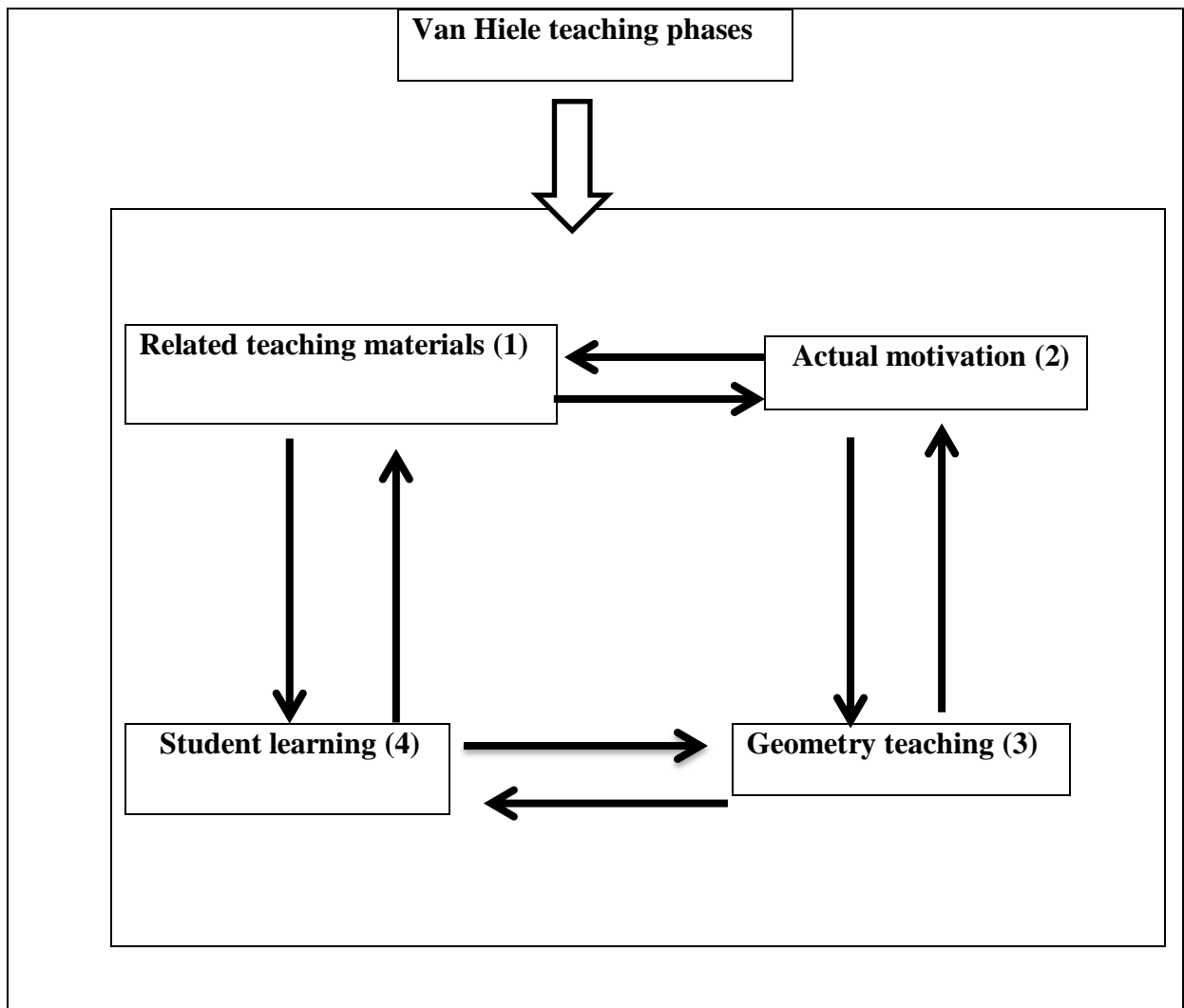
Phase-5: Integration: Students build summary of all they have learned about the objects of study integrating their knowledge into a coherent network that can easily be described and applied. The researcher's role is to encourage students to reflect on and consolidate their geometric knowledge, increasing emphasis on the 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 lower secondary level using the above discussed theoretical frame of learning geometry through instruction in the class on the basis of experiment.

Conceptual Framework

This study had used theory of Van Hiele approach of teaching geometry students at grade seven students. The conceptual framework is the road map of study. Teaching material, method, environment, class room management, students motivation, etc. are main factor of teaching in classroom. As that Geometry teaching is most related to material. So the Van Hiele approach is suitable for geometry teaching students at grade seven. Student motivation is most important part of the learning.

Researcher create the conceptual framework on the base of Bhandari(2014) "*Effectiveness of Geogebra-assisted instruction in math at secondary level study*". The researcher modified the conceptual framework which as his need on the basis of objectives.



Motivation is the most important role of the teaching learning activities. So the researcher using related materials and learning theories (Van Hiele phases) of geometry teaching in classroom of lower secondary level. Learning theory and related instructional materials are most supported the students' motivation of geometry teaching. Also, the Van Hiele approach phases of geometry teaching easy to learned and visualized the abstract concept of geometric problems. So the researcher made the above conceptual framework in the study. The researcher developed the teaching episode basis were Van-Hiele phases of teaching geometry and to measured the achievements of geometry in grade seven students'

Chapter-III

METHODS AND PROCEDURE

In this chapter, design of study, population and sample, tools of the study, calculation of reliability, items analysis, selection criteria, data collection procedure, data analysis procedure have been described and discussed.

Design of the Study

This study is an experimental type design, having two group experimental and control groups. The pre-test and post-test non-equivalent control group was adopted for the purpose of this study. The paradigm of the study is as follow:

Pre-test	Groups	Treatment	Post-test
T_1	E	X	T_2
T_1	C	Y	T_2

Where,

T_1 = Pre-test given by two (Experimental and Control) group

E = Experimental group

C = Control group

X = Van-Hiele approach of teaching phase treatment

Y = Traditional approach treatment

T_2 = post-test given by two (Experimental and Control) group

Population of the Study

The grade seven students enrolled in the public schools of the Surkhet district of Nepal constituting as the population of the study. In order to carry out the experimental method of the study was carry out in Janata Higher Secondary School Vidyapur-4 Surkhet.

Formation of Control and Experimental Groups

The researcher in these studied already divided two groups (Sec A and Sec B) at grade seven students was given an achievement test paper. Suppose the researcher one group was experimental and other group was control group (E and C) by using tosses the coin. In this studied was conducted in class seven at Janata Higher Secondary School Vidyapur -4 Surkhet.

Variable and Controlled Exercise in the Experiment

There are many variables that affect the research findings such as dependent variables, independent variables, and extraneous variables. Here in my study Van Hiele approach was independent variable whereas students' achievement was dependent variables. Furthermore, other variables can also affect in any kind of research findings except independent variables those variables are called extraneous variables such as home environment, students maturation, statistical mortality, teacher, student, length of experiment and so on. All the variables cannot be controlled by the researcher likewise student home environment, students maturation, statistical mortality, intelligence and communication. Therefore some of the variables which can directly affect the research 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 duration of different period (second period and forth 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 government in Nepal.

Students: Both groups were selected from class VII of the same government school (Shree Janata Higher Secondary School Vidyapur-4 Surkhet). Students in both groups were different. Control group using by traditional method teaching and an experimental group were using Van Hiele model phase of teaching geometry.

Evaluation applied: After the end of the experiment, the same test was given to the experimental and control groups. The researcher himself marked the test paper of the students. Therefore, the variation in made of test paper was reduced. Thirty students of first group where selected for Van Hiele model phases of teaching geometry for experimental groups and same school student thirty students of second group were selected for traditional teaching methods for control groups.

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

Sample of the Study

Sample is a part of research universe, which is selected from a defined target population of representative for the purpose of investigation. The purpose of selecting sample is to obtain representative for the purpose of investigation. The purpose of selecting sample is to obtain representative data about population to draw the results.

The main motto of this study was to explore the effectiveness of Van Hiele model phases of teaching geometry. The experiment was carried out in Janata Higher Secondary School, Vidyapur in Surkhet district. The sample school was selected purposively to select an average standard of school in terms of its result in Grade VII examination, physical facilities, and socio-economic attitude towards the study.

There were 60 students' in grade seven in Janata Higher Secondary School, who were already divided into 2 groups as Sec-A and Sec-B. Each Section had 30 students' in number. Researcher devoted equal time duration to teach both groups and in both groups by using two different techniques. The researcher taught both groups for one month in second and forth period in school time duration. The experimental group was taught by Van Hiele model phase of teaching geometry in second period of school day and control group was taught by traditional method of geometry teaching in forth period of school day.

Stages of Experiment

The researcher collected the data for the intending research analysis from the experiment. Van Hiele model phases of teaching geometry, was experiment in the schools where traditional approach of teaching was used. The stages of experiment can be briefed as:

Pre-experimental Stage: It is the stage in which researcher obvious two groups has to test the event to identify present situation of any event before condition the research detail information are collected regarding event. Prior the test of any proposal is prepared, and then appropriate tools are selected. By using suitable tools coin tossing method into divided two group's i.e. Experimental and Control group. Then the pre-test is taken of each group and mean value, standard deviation, coefficient of variance of each group is measured.

Experimental Stage: In this stage obvious two separate group are taught by different techniques i.e. experimental group is taught by using Van Hiele model phases of teaching geometry and all the possible extraneous variables are controlled for the effective has of this method, were as controlled groups is taught by using

traditional method in teaching geometry. Also, both group taught at least one month in same content.

Post experimental Stage: It is the last stage experiment in which two groups which had been taught by two different methods during experimental stage are evaluated by taking their post-test and comparing mean and standard deviation and coefficient of variance of each group obtain from pre-test and post test. Also the accurate validity of our experiment T-test is taken by using appropriate and identify conclusion.

Data Collection Tools

The researcher used mainly two kinds of achievement tests pre-test and post-test respectively. Observation note and interview were also used as data collection tools in this study. The major data collection tools of the study are discussed below.

Achievement Test: The researcher developed achievement tests conserving of subject type questions (vary short question: $8 \times 1 = 8$, short question: $5 \times 2 = 10$, and long question: $3 \times 4 = 12$) as tools for the study. Test items were developed on the basis of prescribed curriculum and textbook of grade seven (Triangle, Quadrilateral, and polygons). On the basis of the specification chart with matrices of five phases including five different skills (information, Directed orientation, explication about figure, free orientation and integration) according to Van Hiele model phases of teaching geometrical ideas, test items were chosen and constructed. The researcher developed test consisting 16 items. And the developed test items were distributed to three school teacher and two mathematics educators to assess the validity and errors on language, complexity and suitability of the items. With the suggestions and changes given by the concerned authority were included in the achievement test items

and administered in others school (Jivan Joti Secondary School) students' at grade VII.

Observation Note: Observation was one of tools of data collection. I made an observation format to consulting with the supervisor which in the appendix-I and observe the classes basis for the conceptual framework. This format contains students activities, Van Hiele approach teaching phases, and shared personal practice. According to this format I observed the classes doing my experiment. Then I made conclusion from the observation note.

Interview Schedule: The researcher taught to experimental group with Van Hiele approach and taught control group with traditional method. Interview used to 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 that 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 prevented in appendix-H. Also, I interview is taken format the experimental group only where six students were interviewed. In interview process, the researcher not only asking the question but also observed all behaviour and answering method of respondents.

Reliability of the Test

According to the Huck and Cormier, basic idea of reliability is summed up by consistency. A test is considered reliable if we get the same result repeatedly. In this study, test involving 20 students were piloted. By applying the split-half method, reliability of the test were determined. The reliability of the test was indicated mathematics achievement is reliable.

The split- half method (odd-even) was used to test score obtained by students who formed the sample of students of this study. The calculated value of reliability was 0.62. It was found that the pre test and post test item was reliable. Thus, the calculation of reliability table is presented in (Appendix-C).

$$\text{Reliability of the full test} = \frac{2 \times \text{Reliability on } \frac{1}{2}}{1 + \text{Reliability on } \frac{1}{2}}$$

The calculate reliability value of the even and odd group were found 0.62. Since the reliability is always in -1 to +1. The greater value of the tool of measurement the greater the reliability of measure but the smaller value of the tool of measurement the smaller the reliability. Generally, reliability coefficient was interpretation following.

Therefore, calculated reliability coefficient are in $\pm(0.60-0.79)$. Thus, the measurement tools of the groups were high reliability. It implies that this research tool was dependable, stable, consistent, predictable and accurate.

Validity of the Test

Validity is the degree to which a test measures what is supposed to measure. Since a test is valid for a particular purpose and for a particular group therefore the mathematics achievement test was developed for measuring the effectiveness of Van Hiele approach teaching geometry as well as the grade seven students. For the estimation of validity of this test was an establishing through expert ratings. Expert judgment indicated that the term were representative for content coverage.

For the estimation of the validity of the test the tools was developed study's curriculum text book, grid previous test and was serious. Also, with the help of mathematics teacher and supervisor concluded to judge whether the test does what it intended to measure.

Items Analysis

For the reliability of the test it was administered in a school as pilot studies. The scores of the test were collected in a frequency distributed table. The test was administered as a pilot study in Jivan Joti Secondary School among 20 students, Vidyapur Surkhet. There were 18 questions including very short (10 questions having 1 mark pre question), short question (5 question heaving 2 marks) and long question (3 question heaving 4 marks). A correct response was scored '1' for very short and '2' for short and long and '0' for incorrect as shown in table 4. Level of difficult and power of discrimination of each item were calculated on the basis of 27 percent of students who scored high and 27 percent who scored low.

The difficulty level (p) is defined by the formula

$$P = \frac{U_{R+L_R}}{U_{N+L_N}} \text{ and}$$

$$\text{The discrimination index (D) by } D = \frac{U_{R-L_R}}{U_{R \text{ or } L_R}}$$

The P-value and D- index of each item is denoted by P and D respectively (see Table 4). The item difficult y level P is accepted between the range 30 to 80 whereas discriminating index (D) is accepted 0.20 to 0.90 onwards. Three items (2 very short, 1 long) were rejected after items analysis, so only 16 items were chosen (30 marks) for the achievement test items. (See Appendix-B)

Data Collection Procedure

The researcher developed the data collection tools subjective types test items as main tools. Also, the researcher used the constructed test items in another school (Jivan Joti Secondary School) grade seven students to maintain validity and reliability as well as items analysis. The rejected items from the item analysis were removed then administrated in this way (very short $8 \times 1 = 8$, short $5 \times 2 = 10$ and long $3 \times 4 = 12$)

pre-test and post-test. The researcher took pre-test in 2073-06-13 existed two groups at grade seven in Janata Higher Secondary School Vidyapur Surkhet. The experimental group and control group were taught by the researcher himself for one month. The researcher taught the experimental group in second period of each school day by Van Hiele model phases of teaching geometry with developed teaching episode. Also the control group was taught using traditional method of teaching geometry in forth period of each school day.

At the end of teaching, the standardized achievement test (same pre-achievement test) was administered in both groups for 2073-08-08 of the students. They were inspired to answer freely and without any discussion among themselves. The time allotted to the test was 1 our which was stipulated based on the calculation of average time taken by each student in pilot testing. After the time direction of examination the answer sheets were collected. Also the answer was scored by the researcher and then the score were tabulated for the analysis. Moreover, for qualitative data collection part was completed through the asking open questions to the students in interview and observing the students behaviors and made note.

Data Analysis Interpretation Procedure

The quantitative data obtained from experimental and control groups analysed by statistical tools and devices. Mean, standard deviation, variances and C V were calculating from two groups with their obtained marks in the test. Two tail t-test for the independent samples used using at 1% levels of significance different and to find whether the difference of mean is statistically significant by using the method of pooled variance formula.

Collected data of this research was analysis quantitatively as well as in qualitative way. The qualitative data for this thesis was obtained from observation

note and interview scheduled with thematic analysis. Collected information from the observation of classroom activities of the students' and the researcher made the open questions taken interviews of the students' were analysed in a deductive way. Noted information was described based on participation of students' in all the classroom activities, discussion, activeness and capacity of problem solving. From the information, researcher searched the effect of participation, discussion, activeness and capacity of problem solving. Finally, analysis, interpretation and conclusion were prepared through developing table, as well as description.

Quantitative Data

For data collection, researcher used achievement tests mainly. Both the experimental and control groups were taught by researcher himself. The experimental group was taught by using Van Hiele phases of teaching geometry. And the control group was taught by using traditional method of teaching geometry. After completing the experiment the researcher administered the achievement tests which were constructed by researcher for the both groups.

Qualitative Data

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 six 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 the researcher analysing the answers of the students'.

Data Analysis Procedure

The collected data was analysed and interpreted statistically. Descriptive statistics such as mean, standard deviation and variations of both experimental and control groups were calculated to know the differences in achievement before and after the experimentation. And the collected data was presented in quantitative way. Related mean achievements were compared by using t-test at 1% level of significance. For the qualitative analysis, collected information from the class room observation and interview schedule was analysed in descriptive ways. The researcher used the following statistical procedure to analyse the obtained data: mean, standard deviation variance and t-value. Also were calculated as the scores obtained by the students to compare the result of pre-test and post-test.

Where,

The critical value of t-test is found for N_1+N_2-2 , degree of freedom.

Chapter IV

ANALYSIS AND INTERPRETATION

This is an experimental research related to find the effectiveness of the Van Hiele approach in teaching geometry at lower secondary level of school grade VII. The objectives of this study, were to compare the Van Hiele approach and traditional approach of teaching geometry at grade VII students, and to find out the attitude of Van Hiele approach in teaching geometry at grade VII students. Pre-test, post-test, non- equivalent group design were adapted. For this, 54 students were taken as sample from the selected school (Janata Higher Secondary School), as experimental and control groups respectively. The main tools of data collection were achievement tests. Pre-test was administered before the experiment started and the post-test was administered after the experiment. Then comparing the achievement score of pre-test and post-test of both group were analysed using t-test at 1% level of significance. To maintain the reliability of the tests I used Split-half method. Likewise, to find the attitude of the Van Hiele approach of teaching geometry the researcher observation and interview. The collected data analysed and interpreted under these headings :

Comparison of Mean Achievement Score of Experimental and Control Groups on Pre-test in this section.

Analysis of Pre-test Result

Scores of the pre-test of the students of the experimental and control groups are presented in Appendix A. also the statistical calculation of the pre-tests of both groups is presented in table 2.

Table No. 2 Comparison of Pre-test Result

Groups	N	Mean(\bar{X})	SD (σ)	C V	Variance(σ^2)	α	t_{-value}	Remar ks
Experimen tal Group	2 7	12.11 (40.36 %)	3.15 (10.5%)	26.011 %	9.95 (33.16%)	0.0 1	-0.63	H_0 Accepte d
Control Group	2 7	11.55 (38.5%)	3.37 (11.23 %)	29.17 %	11.40 (38%)			

The mean and standard deviation of the pre-test of the experimental and control groups are 12.11, 11.55 and 3.15, 3.37. The researcher established two Non-equivalent groups on the basis of coin tossing way. Pre-test was taken as purpose to find out the level of achievement scores in the mathematics of both experimental and control groups before conducting treatment. Above table shows that the calculated t-value ($t=-0.63$) does not exceed the critical value ($\alpha=0.01$) at 1% level of significance. Therefore we accept the null hypotheses. That means there is no significant difference in the achievement scores of the both groups. Thus before conducting the treatment both experimental and control groups have same level of achievement scores in mathematics.

Different researches have shown that Van Hiele approach is more effective to teach geometry. Here in my study the achievement level of two groups is same after taking pre-test. Therefore, I want to teach the experimental group using Van Hiele approach with the phases of teaching geometry. And I hope that after teaching with

the phases of teaching geometry to the experimental group the level of achievement will be high than the control group. If I find the high level of achievement of experimental group than the control group that would be effect of the Van Hiele approach phases of teaching geometry.

Analysis of Post-test Result

Score of the post-test of the students of the experimental and control groups are presented in Appendix B. Also the statistical calculation of the pre-test of both groups is presented in table 3.

Table: 3 Analysis of Post-test Result

Groups	N	Mean(\bar{X})	SD (σ)	C V	Variance(σ^2)	t_{-value}	α	Remarks
Experimental	27	18.88 (62.93%)	4.48 (14.93%)	23.72%	20.095 (66.98%)	-3.22	0.01	H_1 <i>Accepted</i>
Control	27	14.88 (49.6%)	4.65 (15.46%)	31.25%	21.61 (72.033%)			

The mean value and standard deviation of the scores of post-test of experimental and control groups are 18.88, 14.88 and 4.48, 4.65 respectively as shown in the above table. In order to test the null hypothesis of the study the researcher established two non-equivalent groups of the students. Post-test was taken as the purpose 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 ($t = -3.22$) is exceed critical value ($\alpha = 0.01$) at 1% level of significance. Therefore, we accept the alternative hypothesis in the achievement score of both groups. This means after conducting the treatment to the both groups experimental and control had different level of achievement scores in mathematics.

So, analyzing the result of the post-test conducting in both groups the level of achievement was found higher in experimental than control group. Therefore, I claim that the reason of getting higher level of achievement of experimental group than control group is the effect of Van Hiele approach phases of teaching geometry. There were no other variables to affect in the result of the experimental group.

Achievement between Control and Experimental Groups

The pre-test and post-test scores of experimental and control group are presented. Also the summary of statistical calculation for both groups on the pre-test and post-test are presented in the table.

Table: 4 Comparison base in the Total Average

Group	Pre-test (Mean)	post-test (Mean)	Pre-test (SD)	Post-test (SD)	pre-test (C V)	Post-test (C V)
Experimental	12.11	18.88	3.15	4.48	26.011%	23.72%
Control	11.55	14.88	3.37	4.64	29.17%	31.25%

In this unit achievement of the students are observed and macro level of comparison between the achievement of the experimental and control groups is presented. The above table shows that the mean score of the students of experimental groups is increased by 6.67 averages out of 30 marks of 27 students. Mean score of the control group is increased by 3.33 averages out of 30 marks of 27 students. The progress rate of control group was only 3.33 averages which is vary low in comparison with mean score of experimental group (6.67 average). The whole achievement scores of experimental group performance was more then the control group because the SD value of scores of the experimental group was 4.48 in comparison to 4.64 of control group. Also, the achievement score of experimental

group was more consistent or more uniform than the control group. Because the C V value of score of the experimental group was decreased but the C V value of score of control group was increased.

Thus the researcher concludes that the achievement of the grade VII students who were taught geometry using Van Hiele approach phases of teaching geometry is better than the students who were taught using traditional teaching method in geometry. Therefore, I can claim that Van Hiele approach in teaching geometry is more effective as I found result in my experiment which is presented table no 4.

Effectiveness of Van Hiele approach in teaching Geometry

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

Students point of View

Researcher developed observation note and interview schedule question. Then take the responses of the students with used appendix-H and daily note and they were noted. The researcher observed students' motivation, student's class activities and student's behaviour 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

motivated in the class. The students' of control group were seemed monotonous and not interested in the geometry teaching. Moreover, 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 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' view.

The students of experimental group was expressed that geometry is not as much difficult as they have previously assumed. They found the geometry portion interesting, visualize, and easier than the other mathematics portions like algebra and arithmetic. In experimental group, most of the students' were found interested in classroom activities and showed active problem solving techniques. Moreover, the must 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, student-teacher discussion and visualizing the abstract concept of geometry"*. This shows that Van Hiele the 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 the 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 for the students. They did not participate in the group discussion and group work. 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 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.

"Few students said that there is no significance different between two methods in teaching geometry. Then the researcher diagnoses his problems observing his behaviour in his experimentation and found that he had been presenting irregularly in the period of experimentation and his previous progress report was also poor and seemed uninterested in Mathematics". But the student achievement score of post-test is better than the pre-test scores. Also, the students of experimental group were regularly participated in the class and did homework, discussed the geometrical problems by consulting the teacher. Students' said that, *" if all the mathematics teachers would have used this method our understanding level was high achievement in geometry"*.

Above explanation shows that Van Hiele approach in teaching phases of geometry was better to teach geometry at lower secondary level than traditional method. Most of the students were interested to Van Hiele approach in teaching activities. Students believed that Van Hiele approach supports easier understanding

geometrical concept and using learning by doing and group discussion process. Thus Van Hiele approach to support the students learn geometrical concept.

Chapter - V

FINDING, CONCLUSION, AND RECOMMENDATIONS

This study was an experimental where as researcher developed two types teaching activities traditional and Van Hiele approach. Researcher used Van Hiele approach in experimental group and traditional method in control group. After the experimental stage the researcher took the achievement test on each group. On the basis of the achievement of the students the researcher obtained following summary, finding, conclusion and recommendation.

Summary

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 lower secondary school students. To fulfill 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 traditional 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 choose lower secondary school from the area of Surkhet distinct. Then researcher took pre-test from the same class seven dividing into two groups. Researcher made experimental and control groups to already existed groups (Sec A and Sec B) by method of rolling the coin. Also, the researcher used Van Hiele approach in experimental group and traditional approach in control group taught them geometry. After that researcher taught with the developed stages and observed the class activities and students behavior. Therefore, the researcher took post-test of both groups according as questionnaire. Both tests consisted 8 objective multiple type item, 5 short type item and 3 long type item on the

area of geometry (Triangle, Quadrilateral and Polygon) from grade seven. Researcher also developed observation questions for interview for the students to know their changed behavior and attitude towards Van Hiele approach.

The researcher analyzed result of pre-test and post- test of the both group by using statistical devices such as mean, standard deviation, variance and t-test on the bases of topics analysis of pre-test. Then comparing the achievement of the both groups experimental and control groups' post-test, measured gain of deductive reasoning and qualitative data analysis respectively. In this research, researcher also gathered qualitative data by using daily note student activities, behavior, observation note and interview. The information collected from the observation then researcher analyzed organization of data, summarizing the data and interpreting the data. Researcher explained the data and their perspectives according to the responses of the respondents.

Findings

From the existing statistical analysis of the data leads toward the following results as the major findings of this study. The achievement of the grade VII students who were taught geometry with using Van Hiele approach teaching achieved better achievement than the students who were taught using traditional methods. 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 difference 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. Then the researcher was drawn following finding.

- Analysis of the mean, S.D, 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 showed that there was no significance difference between mean achievement of experimental and control group.

- The student's achievement of the post-test was greater than student's achievement of the pre-test. It means both teaching approaches help to learn geometry teaching in lower secondary level.
- Analysis of the post-test mean score between the experimental and control groups showed that there was significance difference to teach geometry to both groups. The experimental group was taught using Van Hiele approach and get better results in comparison to a control group.
- Analysis of the qualitative data most of the students expressed that Van Hiele approach was suitable teaching method in geometry because it is easily understanding, to given the idea of problem solving, interesting the classroom activities in geometry teaching.
- Finally, the main finding of this study was "Van Hiele approach in teaching geometry is effective than the traditional approach in teaching geometry" at lower secondary level students.

Conclusion

In this study the researcher found that the mean achievement score of the students taught by Van Hiele approach was higher than the students taught by using traditional teaching approach in geometry. In conclusion, this study reveals that Van Hiele approach can be more effective than the traditional method in teaching geometry at lower secondary school level. From the result of this study it can be concluded that the Van Hiele approach helps students to understand geometry and consequently perform better in achievement test over traditional teaching method.

Additionally the Van Hiele approach helps students to motivate and apply the known geometrical concepts in unfamiliar condition.

Recommendations for Stakeholder

From this finding and conclusions the researcher suggested the following accommodations.

- The mathematics teacher should be encouraged to use Van Hiele approach in teaching geometry.
- The teacher training institutes should focus their attention on Van Hiele approach of teaching mathematics in the pedagogy course which is not yet introduced.
- The mathematics teacher should be encouraged to used Van Hiele approach in teaching geometry at lower secondary level especially on geometry teaching.
- Curriculum designer, textbook writer should emphasize on the Van Hiele approach. In preparation of mathematics textbook, emphasis should be given on Van Hiele approach and strategies throughout school mathematics.
- Students should be encouraged to get involved in active participation in classroom activities.

Recommendations for Further Researcher

The following suggestions are made for further researcher:

- The study was confined only to the Surkhet distinct. Therefore, further studies should be done in different districts of Nepal and the results of the study can be generalized.
- It would be worth while to study the opinions and attitudes of teachers and pupils toward the use of Van Hiele approach with teaching module.

- This study was conducted only for area of geometry specially Triangle, Quadrilateral, and polygon of grade seven students. Therefore, further researcher should be done in different area of geometry and different level students. Also the result of the study can be generalized.

REFERENCES

- Van Hiele. D. & Pierre M. (1984). *A child's thought and geometry*. In English translation of selected writings of Dana Van Hiele- Geldof and Pierre M. Van Hiele, edited by D. Fuys D. Geddes and R,W. Tischler, 1959/1985. Brooklyn: Brooklyn College.
- Kelly, P .J & Ladd, N. E. (1986). *Fundamental geometry*, Eurasia publishing house (P) Ltd. Delhi.
- Burger, William F & J. Michael Shaughnessy. (1986). "Characterizing the Van Hiele level of development in geometry". *Journal for research in mathematics education 17 (January):31-48. doi: http://dx. doi./10.2307/749317*.
- Pierre. M. & Van-Hiele D. (1950), Development model geometry thinking level. *Images.rbs.org/Cognitive/Van-Hiele.shtm*
- Choi-koh Sang Sook. (1999). "A students' learning of geometry using the computer." *Journal of educational research 92(5): 301-11. Doi: http://dx.doi.org/10.1080/00220679909597611*.
- Usiskin, Z. (1982). *Van Hiele and achievement in secondary level geometry (final report of the cognitive development and achievement in secondary school geometry project)*. University of Chicago, Department of Education.
- Clements, Douglas H. (2003). *Teaching and learning geometry*. In a research companion to principles and standards for school mathematics, edited by Jeremy Kilpatrick, W. Gary Martin and Deborah Schafer, pp. 15-78. Reston VA: National council of teachers of mathematics.
- Clements, D. H. (2004). *Perspective on the child's thought and geometry*. Reston: National council of teachers of mathematics.

- Lamsal, S. (2005). *A study on the effectiveness of Van- Hiele approach in teaching geometry at lower secondary school students*. An unpublished master's thesis, T.U. Kirtipur, Kathmandu.
- NCTM. (1989). *Curriculum and Evaluation standards for school mathematics*. Reston; V A: National curriculum of teacher mathematics. Inc.
- Oli, K. (2011). *Students Van Hiele level of geometric through and its relationship to their achievement in mathematics: A survey study in Salyan district*. An unpublished master's thesis, T.U. Kirtipur, Kathmandu.
- Oli, N. (2013). *Van Hiele level of geometric thought and mathematics achievement of students*. An unpublished master's thesis, T.U. Kirtipur, Kathmandu.
- Wallace, C. & West, F. (1989). *Rodts to geometry (2nd ed.)*. Prentice Hall Upper Saddle River, NJ 07458.
- Ghemire, S. (2010). *A study on the achievement of grade VIII students in geometry at Lamjung distinct*. A survey study an unpublished master's thesis, T.U. Kirtipur, Kathmandu.
- Bhandari, P. (2014). *Effectiveness of geogebra-assisted instruction, in math at secondary level*. An experimental study of the unpublished master's thesis, T.U. Kirtipur, Kathmandu.
- Gyawali, S. (2009). *Effectiveness of Van-Hiele approach in teaching geometry at secondary Level*. An unpublished master thesis, T.U. Kirtipur, Kathmandu.
- Howse, D. & Howse, E. (2014). National curriculum teaching mathematics. [http://www.nctm.org/publication/teaching-children-mathematics/2014/vo/21/issues/linking-Van-Hiele- Theory-to-Instruction](http://www.nctm.org/publication/teaching-children-mathematics/2014/vo/21/issues/linking-Van-Hiele-Theory-to-Instruction).

NCF (2063). *National curriculum framework of mathematics education*. Government of Nepal, Ministry of Education, Development of Curriculum Center Sanothimi, Bhaktapur.

Appendix 'A'

Pre-test score of students of Experimental and Control group out of 30 full marks.

Students	Experimental Group	Control group
1	20	22
2	19	18
3	16	16
4	16	15
5	15	15
6	15	15
7	14	14
8	13	14
9	13	13
10	13	13
11	13	13
12	12	13
13	12	12
14	12	11
15	11	11
16	11	11
17	11	11
18	11	10
19	10	10
20	10	10
21	10	10

22	10	9
23	10	9
24	9	9
25	8	8
26	7	7
27	6	6
N= 27	Mean = 12.11 Variance= 9.95 S D = 3.15	Mean = 11.55 Variance =11.40 S D = 3.37

Correlation between E-group and C- group, $r_{xy} = 0.71$.

Appendix 'B'

Post-test scores of students of Experimental and Control groups out of 30 full marks

Students	Control Group	Experimental Group
1	29	29
2	25	28
3	23	27
4	20	25
5	18	24
6	18	22
7	17	22
8	16	20
9	16	20
10	15	20
11	15	19
12	14	19
13	14	18
14	14	18
15	13	18
16	13	17
17	13	17
18	12	17
19	12	16
20	12	16
21	11	15
22	11	15
23	11	15
24	10	14
25	10	14
26	10	13
27	10	12

N=27	Mean=14.88 Variance=21.61 SD= 4.64	Mean = 18.88 Variance= 20.095 SD = 4.48
------	--	---

Value of t-distribution = -3.22 and $t_{0.005,52} = 2.57$ at $\alpha=0.01$

Appendix 'C'

Statistical Formula Used Data Collection and Analysis

1. Mean (\bar{X}) = $\frac{\sum X}{N}$ Where, X is random variable and N is number of items.
2. Standard deviation (σ) = $\sqrt{\frac{\sum(X-\bar{X})^2}{N}}$
3. Variance (σ^2) = $\frac{\sum(X-\bar{X})^2}{N}$
4. Coefficient of Variance (C V) = $\frac{\sigma}{\bar{X}} \times 100\%$
5. Person's coefficient of correlation (r_{xy}) = $\frac{N \sum XY - \sum X \sum Y}{\sqrt{\{N \sum X^2 - (\sum X)^2\} \{N \sum Y^2 - (\sum Y)^2\}}}$
6. T-test to determine significant difference between two means

$$T = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}} \quad \text{where,}$$

\bar{X}_1 = Mean score of experimental group

\bar{X}_2 = Mean score of control group

N_1 = Number of students of experimental group

N_2 = Number of students of control group

S_1^2 = Variance of experimental group

S_2^2 = Variance of control group

7. Spearman Brown Split-half reliability (r_{tt}) = $\frac{2r_{xy}}{1+r_{xy}}$

Where, r_{tt} = reliability coefficient of whole test

r_{xy} = correlation coefficient between two variable

8. Degree of freedom = $N_1 + N_2 - 2$

9. Difficulty level (P) = $\frac{U_R + L_R}{U_N + L_N}$

10. Discrimination index (D) = $\frac{U_R - L_R}{U_R \text{ or } L_R}$

Where,

U_R = Number of correct response from 27% of upper scoring students.

L_R = Number of correct response from 27% of lower scoring students.

U_N = Total number of 27% of upper scoring students.

L_N = Total number of 27% of lower scoring students.

Appendix D-1

Pre-Required Test Paper

F.M.: 36

Time 1 hr 5min.

gf]6M ;a} k|Zgx? clgao{ 5g.

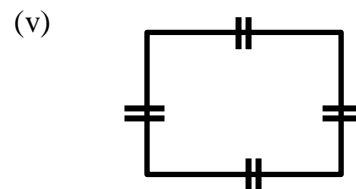
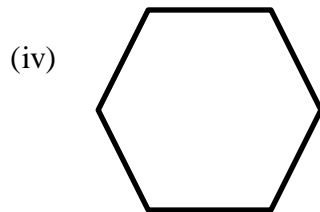
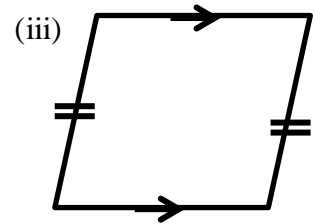
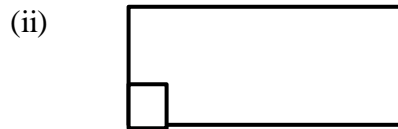
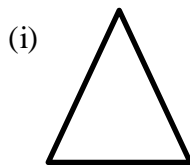
sIff:

;ft

;d'x s $10 \times 1 = 10$

k|=g=1. IgDg HoldtLo lrqx?nfO{ gdfsf/0f u/.

|



k|=g=2. Igoldt ax'e'hsf] Pp6f pbfx/0f b]p <

k|=g=3. lqe'hdf hDdf sltj6f e'hfx? x'G5g<

k|=g=4. ;Dd'v e'hfx? a/fa/ eosf] rt'e'{hnfO s] elgG5 <

k|=g=5. cfotsf k|Tos sf]0f slt l8u|Lsf x'G5g <

k|=g=6. rf/cf]6f e'hfx? ldnL ag]sf] aGb cfs[ltnfO{ s] elgG5 <

$$;d'x v 5 \times 2 = 10$$

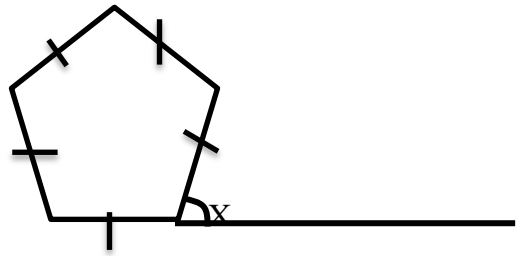
$k|=g=7$. :s]nsf] k[of]u u/L $AB=5\text{cm}$, $Bc=4\text{cm}$, $AC=6\text{cm}$ ePsf] lqe'hsf] /rgf u/.

$k|=g=8$. ;dfgfGt/ rt'e'{h / cfotsf u'0fx? aL]r kfOg] leGgtf n]v .

$k|=g=9$. 4cm nfdf] e'hf ePsf] au{ agfO o;sf s'g}} b'Ocf]6f laz]iftf n]v .

$k|=g=10$. ;dafx' rt'e'{h / au{sf u'0fx?df s] km/s 5 pbx/0f;lxt k'li6u/ .

$k|=g=11$. X sf] dfg lgsfn <



$$;d'x u 3 \times 4 = 12$$

$k|=g=12$. lbOPsf] hfgsf/Lsf cfwf/df lqe'hsf] /rgf u/ .

$$AB= 6\text{cm}, BC= 4\text{cm}, \angle B= 135^\circ$$

$k|=g=13$. ;dafx' rt'e'{hsf k|Tos ljsOf{n] lzif{sf]0fnfO{ cfwfub{5 elg ;lrq sf/0f;lxt

k|df]0ft u/ .

$k|=g=14$. lgoldt k~re'hsf] lelqsf]0f / aflx/Lsf]0f sf] dfg lgsfn .

Appendix E-1

Pre-Required Test Paper

F.M. :30

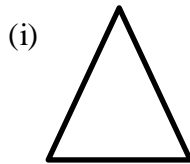
Time 1 hr 5min.

gf]6M ;a} k|Zgx? clgao{ 5g.

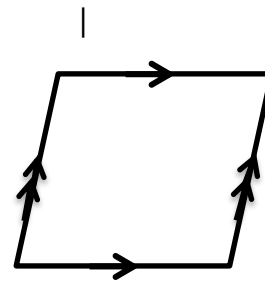
sIff -;ft

;d'x s $8 \times 1 = 8$

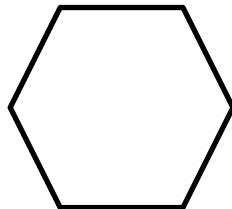
k|=g=1. IgDg HoldtLo lrx?sf] gdfsf/Of u/ <



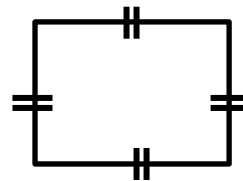
(ii)



(iv)



(v)



k|=g=2. Igoldt ax'e'hsf] Pp6f pbfxf/Of b]p <

k|=g=3. ;Dd'v e'hfx? a/fa/ eosf] rt'e' {hnfO} s] elgG5 <

k|=g=4. cfotsf k|Tos sf]Of slt l8u|Lsf x'G5g <

k|=g=5. rf/cf]6f e'hfx? ldnL ag]sf] aGb cfs[ltnfO{ s] elgG5 <

;d'x v $5 \times 2 = 10$

k|=g=7. :s]nsf] k|of]u u/L AB=5cm, Bc=4cm, AC=6cm ePsf] lqe'hsf] /rgf u/<

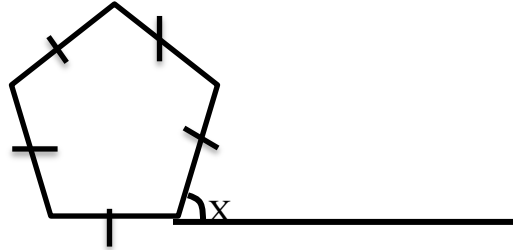
k|=g=8. ;dfgfGt/ rt'e' {h / cfotsf u'Ofx? aL]r kfOg] leGgtf n]v <

k|=g=9. 4cm nfd] e'hf ePsf] au{ agfO o;sf s'g}} b'Ocf]6f laz]iftf n]v <

k|=g=10. ;dafx' rt'e'{h / au{sf u'Ofx?df s] km/s 5 pbx/0f;ixt k'li6u/ <

k|=g=11. X sf] dfg lgsfn <

;d'x u $3 \times 4 = 12$



k|=g=12. lbOPsf] hfgsf/Lsf cfwf/df lqe'hsf] /rgf u/ <

$AB = 6\text{cm}$, $BC = 4\text{cm}$, $\angle B = 135^\circ$

k|=g=13. sDkf; / :s]nsf] k[of]u u/L $AB = 8\text{cm}$ $BC = 5\text{cm}$ / $\angle B = 75^\circ$ ePsf] ;dfgfGt/

rt'e'{hsf] /rgf u/ <

k|=g=14. lgoldt k~re'hsf] lelqsf]0f / aflx/Lsf]0f sf] dfg lgsfn <

Appendix- F

Item Analysis Table

Item No.	Item after rejection	Upper second 27% students														Lower scored 27% students						CR	P	RU	RL	P-value	D-value
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20						
1		1	1	1	1	0	1	1	0	1	1	1	0	0	1	0	1	0	0	1	13	65	5	3	0.66	0.40	
2	2	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	15	2	0	0.16	1	
3		1	1	1	1	1	0	1	1	0	0	1	1	1	1	1	0	0	1	14	70	5	4	0.75	0.20		
4		1	1	1	1	0	1	1	0	1	1	0	1	0	1	0	0	0	1	13	65	5	2	0.58	0.60		
5		1	1	1	1	1	0	1	1	1	0	0	1	0	1	1	0	0	0	1	13	65	5	3	0.66	0.40	
6		1	1	0	1	1	1	0	1	0	1	0	1	1	1	1	1	0	0	13	65	5	4	0.75	0.20		
7	7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	20	100	6	6	1	0		
8		1	0	1	1	1	1	0	1	1	0	0	1	0	1	1	1	0	1	13	65	5	4	0.75	0.40		
9		1	1	0	1	0	1	0	1	1	1	1	1	0	0	0	1	0	0	11	55	5	3	0.66	0.60		
10		1	1	1	0	1	1	1	0	1	0	1	1	1	1	0	0	0	1	13	65	5	3	0.66	0.20		
11		2	2	2	0	2	2	2	2	2	0	2	2	2	0	2	2	0	0	14	70	5	2	0.50	0.40		
12		2	2	2	2	2	0	2	0	2	2	2	2	2	0	2	2	2	0	15	75	5	4	0.75	0.20		
13		2	2	2	2	0	2	2	2	0	2	0	0	0	0	2	0	2	2	13	65	5	4	0.75	0.20		
14		2	2	2	2	2	0	0	2	0	2	2	2	2	2	2	2	0	0	15	75	6	4	0.83	0.33		
15		2	2	2	2	2	2	2	2	0	2	2	2	2	0	2	2	2	0	17	85	6	4	0.83	0.33		
16		2	2	2	2	2	2	2	0	2	2	2	2	2	0	0	2	2	0	16	80	6	3	0.75	0.50		
17	17	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	2	0	0.16	1		
18		2	2	0	2	2	2	2	0	2	0	2	0	2	0	2	2	2	0	14	70	5	4	0.75	0.20		

Appendix- G

Reliability of the test item using by split half method

Students ↓	Odd Items				Even Item				Total Sum
	very short	short	long	Total	very short	short	long	Total	
1	5	4	0	9	5	2	5	12	23
2	5	4	1	10	3	3	4	10	20
3	4	5	0	9	4	2	3	9	18
4	5	2	0	7	3	3	5	11	18
5	3	3	1	7	3	2	4	9	16
6	3	4	0	7	4	1	2	7	14
7	4	4	0	8	2	1	3	6	14
8	4	4	0	8	3	1	2	6	14
9	4	4	0	8	3	1	1	5	13
10	5	4	0	9	2	1	1	4	13
11	3	2	0	5	4	2	1	7	12
12	2	3	0	5	2	2	3	7	12
13	3	3	0	6	1	2	3	6	12
14	2	3	0	5	3	2	2	7	12
15	5	1	0	6	1	2	2	6	12
16	3	3	0	6	4	0	0	5	11
17	4	1	0	5	2	1	1	6	11
18	2	2	0	4	2	2	2	6	10

19	1	2	0	3	0	3	3	5	8
20	4	1	0	5	3	0	0	3	8

Split half reliability of the test

Students	X(Odd)	Y(Even)	X^2	Y^2	XY
1	9	12	81	144	108
2	10	10	100	100	100
3	9	9	81	81	81
4	7	11	49	121	77
5	7	9	49	81	63
6	7	7	49	49	49
7	8	6	64	36	48
8	8	6	64	36	48
9	8	5	64	25	40
10	9	4	81	16	36
11	5	7	25	49	35
12	5	7	25	49	35
13	6	6	36	36	36
14	5	7	25	49	35
15	6	6	36	36	36
16	6	5	36	25	30
17	5	6	25	36	30
18	4	6	16	36	24
19	3	5	9	25	15
20	5	3	25	9	15
Total	132	137	940	1039	941

Where, X= Number of correct response for odd question

Y= Number of correct response for even question

Now, Karl person's coefficient of correlation

$$r_{xy} = \frac{N \sum XY - \sum X \sum Y}{\{\sqrt{N \sum X^2 - (\sum X)^2}\} \{\sqrt{N \sum Y^2 - (\sum Y)^2}\}} = 0.45$$

$$\text{So, reliability of whole test} = \frac{2r_{xy}}{1+r_{xy}} = 0.62$$

Appendix-H

Interviews for the Teacher 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 that van Hiele approach in teaching phases of geometry more enjoyable and memorable than traditional method of teaching geometry?

S.....

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

S.....

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

S.....

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

S.....

.....

Appendix- I

Class observation Note:

Date:

School name:

Note keeping

- Students activities
 - I. Students participation
 - II. Question answer
 - III. Students side taking
 - IV. Feeling the class room 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 practice
 - II. Mentoring and coaching

Sample Teaching Episode

Teaching Episode-1

Topic Name- Parallelogram

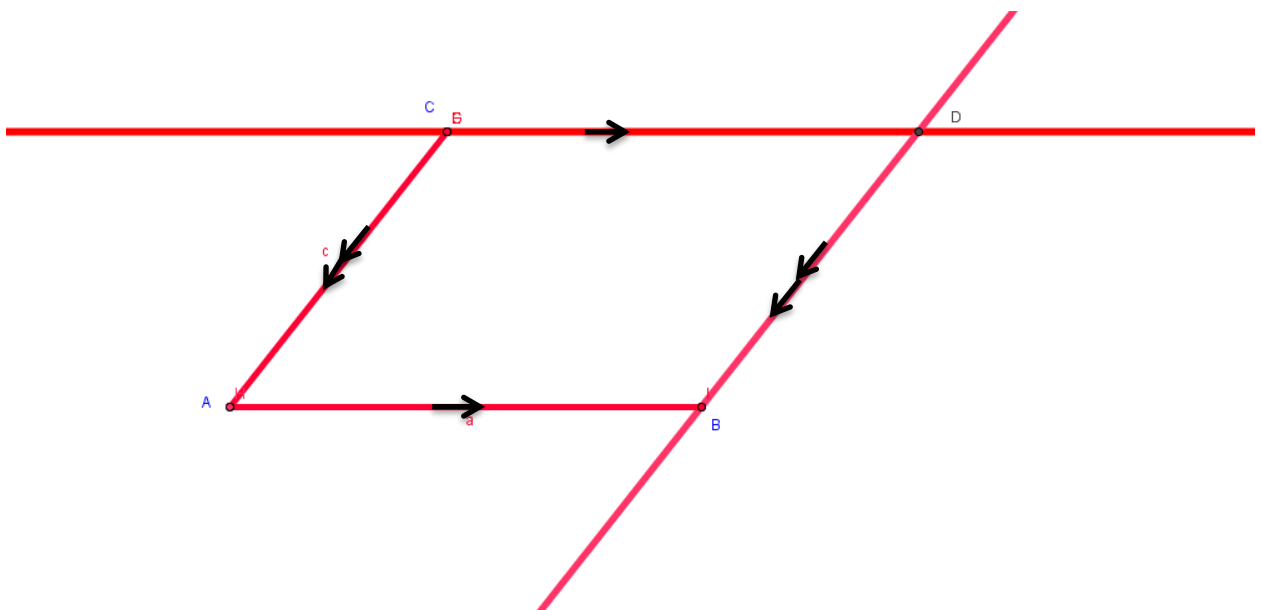
Main teaching point- Review the definition of parallelogram and find the characteristic of parallelogram.

Objectives - All students will be able to identify and state the characteristic of parallelogram.

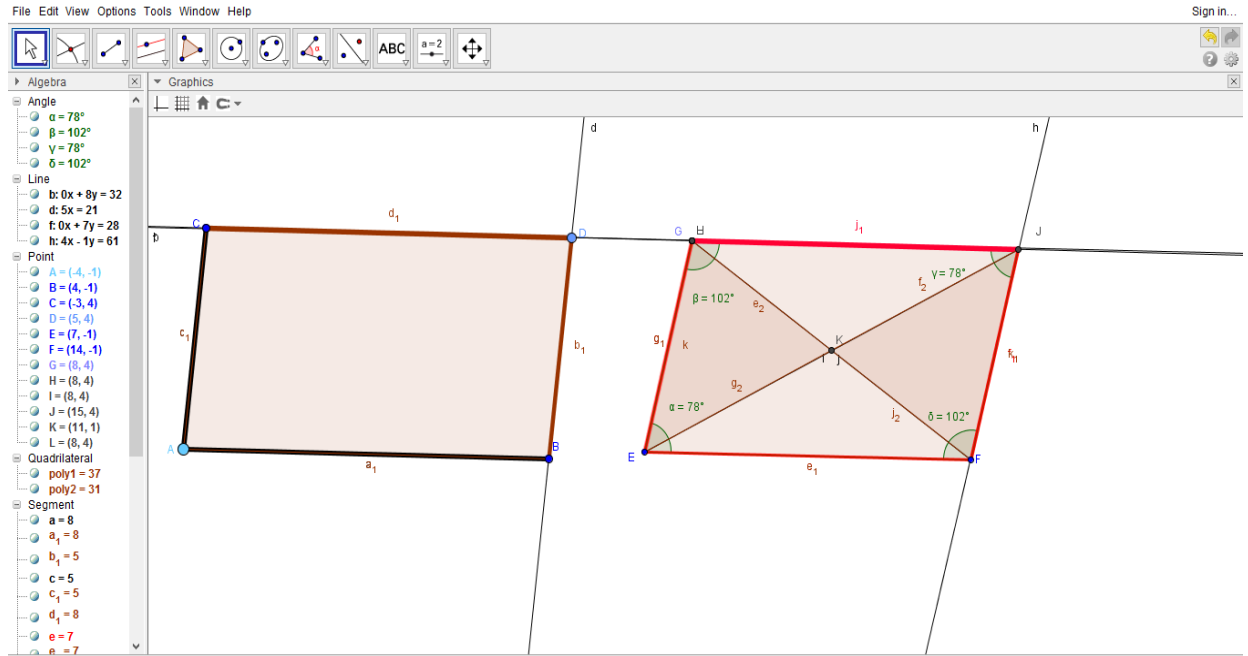
Teaching models:

- 1) **Information :** class discussion
 - What is quadrilateral and draw figure.
 - What is parallelogram to discuss the definition of parallelogram?

- 2) **Guided orientation:** Researcher presents the figure of parallelogram and discusses in this class each them.



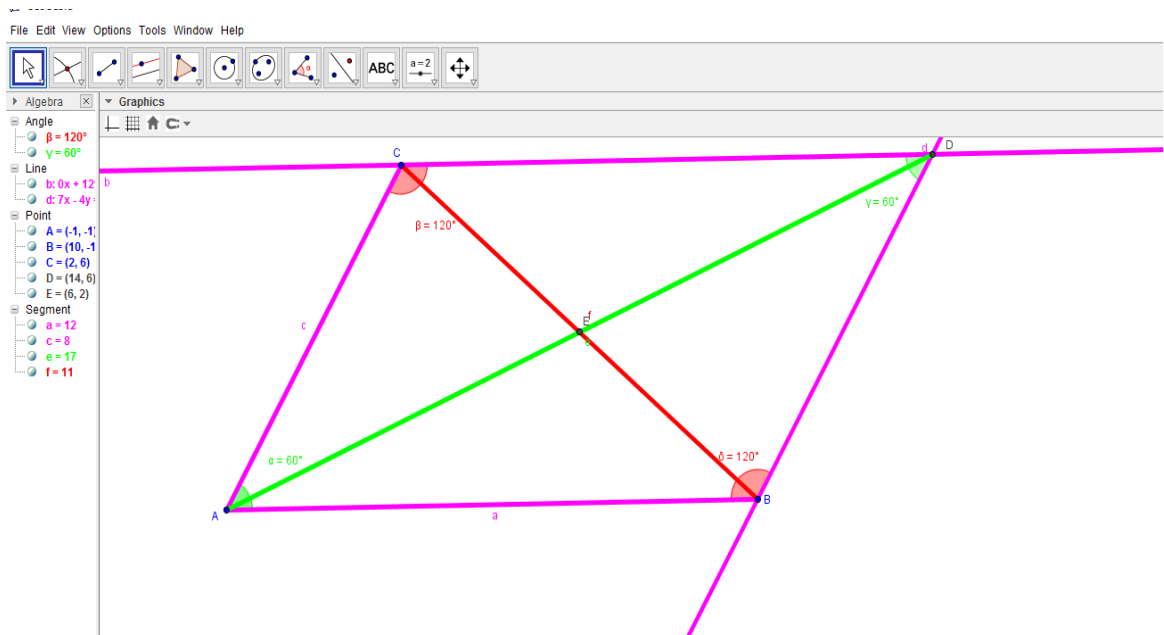
3) **Explanation about figure:** Researcher presents the different figure of parallelogram and to discuss the definition of parallelogram. Also, the discuss the characteristic of parallelogram.



4) **Free orientation** : Group works

Students verify the following characteristic of parallelogram.

- Opposite angles are equal to the all parallelogram.
- Opposite sides are equal to the all parallelogram.
- The diagonal are equal to the mid point of all parallelograms.



- 5) **Integration:** Researcher summarized the all class student activities. And also summarized to: "All parallelogram are quadrilateral but not vice-versa".

*Teaching Episode-2***Topic Name: Characteristics of Rectangle**

Main teaching point: Review the definition of Rectangle and find out the characteristic of Rectangle.

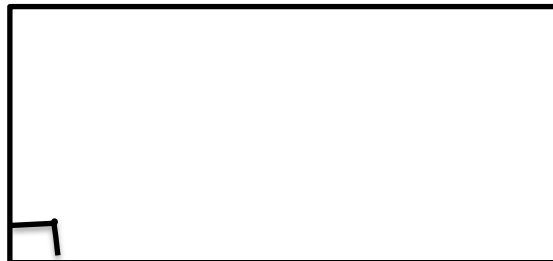
Objective: All students will be able to identify and state the characteristic of Rectangle.

Teaching models:

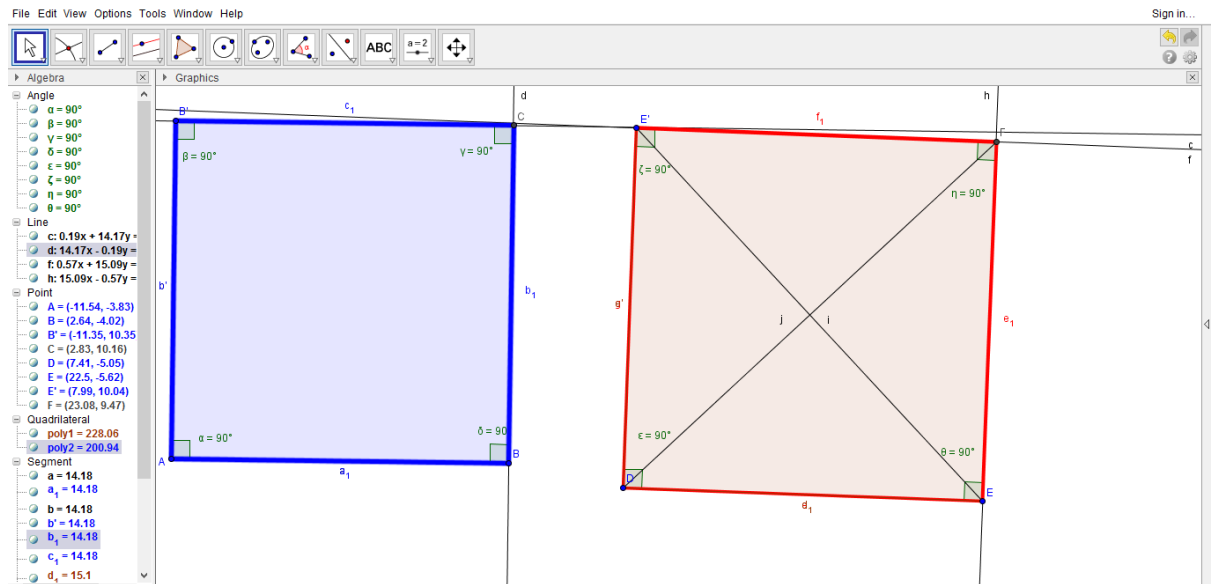
1) **Information :** class discussion

- What is Rectangle and to construct the figure.
- Discuss about the definition of Rectangle.

2) **Guided orientation:** Researcher constructs the Rectangle and discusses of this class its definition.



3) **Explanation about figure:** Researcher to construct the different Rectangle and to discuss the class characteristic of Rectangle.



4) **Free orientation :** Group works

Students verify the following characteristic of Rectangle

- The opposite angles are equal to the all Rectangle.
- The opposite sides are equal to the all Rectangle.
- The diagonals are equal to the mid point all Rectangle.
- The diagonals are equal to the each others all Rectangle.
- All angles are right angles to the all Rectangle.

5) **Integration:** Researcher summarized end of this class in verify the characteristics of Rectangle.

Also, concluded that: "All Rectangles are Parallelogram but not vice-versa.

Teaching Episode-3

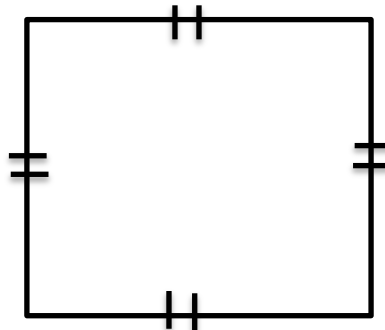
Topic Name: characteristics of square

Main teaching point: Review the definition of Square and to find out the characteristics of Square.

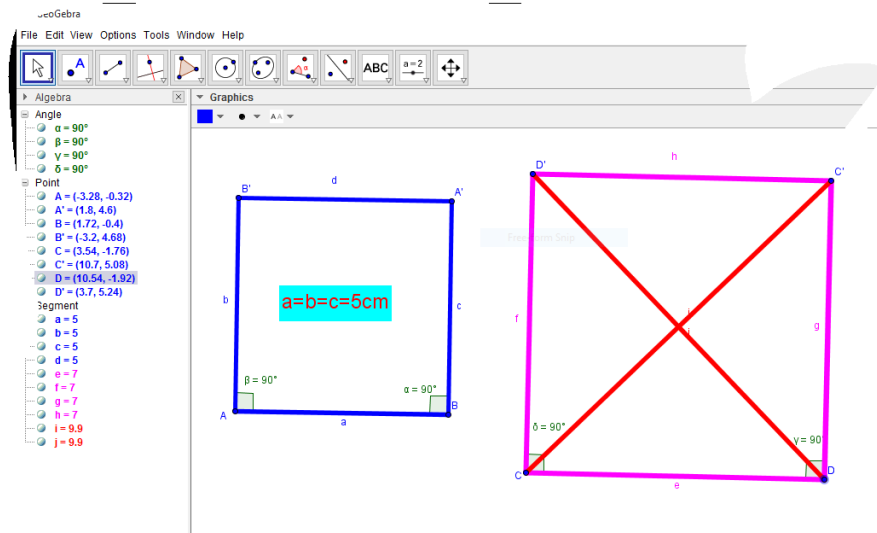
Objectives: All students will be able to identify and state the characteristics of Square.

Teaching model:

- 1) **Information:** class discussion
 - What is Square and to construct the figure.
 - In this class discuss about the definition of Square.
- 2) **Guided orientation:** Researcher to construct the square and in this class discuss about definition of Square.



- 3) **Explanation about figure:** Researcher presents the different size of the figure of square and to discuss the characteristics of this.



4) **Free orientation:** Group works

Students verify the following characteristic of Squares.

- The opposite sides are equal to all square.
- The diagonals are equal to all square.
- The diagonals are divided by right angles to all square.
- The diagonals are divided by vertical angle to all square.

5) **Integration:** Researcher in the end of this class all students active conclude that following "All square are Rectangle but not vice-versa"

Teaching Episode-4

Topic Name: Regular Polygon

Main teaching point: To find out the Interior angles sum of Regular Polygon.

Objectives: All students will be able to verify the formula of Interior angle sum of Regular polygon.

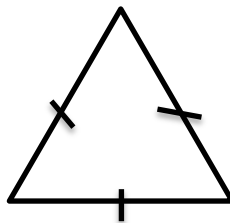
Teaching model:

1) **Information:** class discussion

- What is Regular polygon and given with any example.
- To discuss the characteristics of Regular polygon.

2) **Guided orientation:** In this class researcher to present the example of Regular polygon and construct the figure and discuss about angle sum and side in this figure.

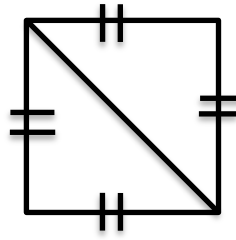
e.g



Name	no. of side	no. of Triangle	sum of Interior angle
Triabgle-	3	$1 = 3 - 2$	$180^\circ = 180^\circ \times (3 - 2)$

3) **Explanation about figure:** Also the researcher present the another example of Regular polygon (e.g square) and discuss about interior angle sum in this.

e.g



Name	no. of sides'	no. of triangles	sum of interior angle
Regular - Quadrilateral	4	$2 = 4 - 2$	$360^\circ = 180^\circ \times (4 - 2)$

4) **Free orientation:** Group works

Students find out the interior angles sum of the following Regular polygon.

Regular pentagon - $540^\circ = 180^\circ \times (5 - 2)$

Regular Hexagon - $= 180^\circ \times (6 - 2)$

Regular Octagon - $= 180^\circ \times (8 - 2)$

.....

5) **Integration:** Interior angle sum of Regular polygon is

$$180^\circ \times (n - 2)$$

Where, $n =$ no. of sides.

Teaching Episode-5

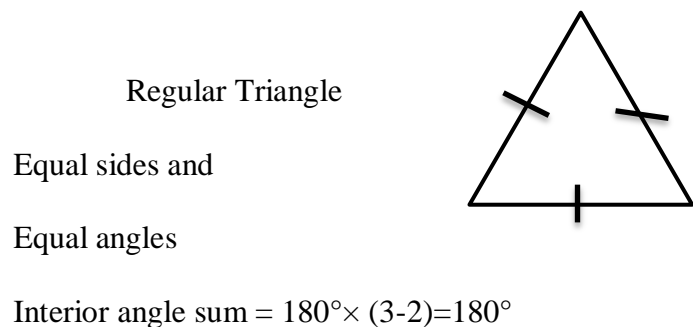
Topic Name: Regular Polygon

Main teaching point: To find the each interior angles of Regular polygon.

Objectives: All students will be able to verify the formula of each interior angle of Regular Polygon.

Teaching model:

- 1) **Information:** class discussion
 - Review what is the Regular polygon and given with example?
 - What is the formula of interior angles sum of Regular polygon?
- 2) **Guided orientation:** In this class researcher present the example of Regular polygon and discuss about characteristic and interior angle sum.
 - Equal sides
 - Equal angles
 - Interior angle sum= $180^\circ \times (n-2)$, where n=no. of sides
- 3) **Explanation about figure:** Also the researcher to present the figure of Regular polygon and discuss following them.



So, that each interior angles is $= 180^\circ/3 = 60^\circ = 180^\circ \times (n-2)/n$, where $n =$ no. of sides

4) **Free orientation:** Group works

Students find the following each interior angle of Regular polygon

- Regular Quadrilateral $= 180^\circ \times (4-2)/4$
- Regular pentagon $= 180^\circ \times (5-2)/5$
-=

5) **Integration:** each interior angle of Regular polygon is $180^\circ \times (n-2)/n$.