VAN HIELE LEVELS AND ACHIEVEMENT IN SECONDARY SCHOOL GEOMETRY

A

Thesis

BY

SANJIT KUMAR RAY

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त्रिभुवन विश्वविद्यालय
शिक्षा शास्त्र केन्द्रीय विभाग
गणित शिक्षा विभाग
TRIBHUVAN UNIVERSITY
CENTRAL DEPARTMENT OF EDUCATION
DEPARTMENT OF MATHEMATICS EDUCATION

विश्वविद्यालय क्याम्पस
कीर्तिपुर, काठमाडौं, नेपाल
UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

पत्र संख्या:-
Ref.

मिति:
Date: .....

LETTER OF CERTIFICATE

This is certifying that Mr. Sanjit Kumar Ray a student of academic year 2070/071 with Campus Roll Number 711, Thesis Number 1637 Exam Roll Number 280518 and T.U. Registration Number 9-2-231-248-2007 have completed this thesis for the period prescribed by the rules and regulations of Tribhuvan University, Kritipur, Kathmandu, Nepal. This thesis entitled **"Van Hiele levels and achievement in secondary school geometry"** has been prepared based on the results of his investigation. I recommend and forward this thesis be submitted for the evaluation as the partial requirement to award the degree of Master Education.

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Prof. Dr. Bed Raj Acharya

Department Head of Mathematics Education

Date: April 5 2021

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UNIVERSITY CAMPUS
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पत्र संख्या:-
Ref.

मितिः
Date: .....

LETTER OF APPROVAL

This thesis entitled **"Van Hiele levels and achievement in secondary school geometry"** submitted by **Mr Sanjit Kumar Ray** in partial fulfillment of the requirements for the Master's Degree in Mathematics Education has been approved.

Committee for Viva-Voce	**Signature**
1. Prof. Dr. Bed Raj Acharya (Chairman)	.....
2. Prof. Dr. Indra Kumari Bajracharya (External)	.....
3. Mr. Krishna Prashad Bhatt (Supervisor)	.....

Date: April 19, 2021

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विश्वविद्यालय क्याम्पस
कीर्तिपुर, काठमाडौं, नेपाल
UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

पत्र संख्या:-
Ref.

मिति:
Date: .....

RECOMMENDATION FOR ACCEPTANCE

This is to certify that Mr. Sanjit Kumar Ray completed his M.Ed. thesis entitled "**Van hiele levels and achievement in secondary school geometry**" under my supervision during the period prescribed by the rules and regulation of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education for the final viva-voce.

.....

Mr. Krishna Prashad Bhatt

(Supervisor)

Date: April 19, 2021

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DEDICATION

This thesis dedicated my respected late grandfather **Raja Ram Ray**, father **Ram Pukar Ray**, mother **Saraswati Devi**, elder brother **Mukesh Kumar Yadav**, wife **Gitanjali Yadav** and all my family members, relative, and friends who support me in every situation of my life.

DECLARATION

This thesis contains no material, which has been accepted for the award of the other degree in any institution. To the best of my knowledge and belief this thesis contains no material previously published by any author due acknowledgement has been made.

Date..... .....

Sanjit Kumar Ray

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ABSTRACT

Prerre Van Hiele and Dina Van Hiele-Geldot developed a model of thinking geometry in late 1950's. The model is applied for identifying the student's level of thinking, designing the instruction for their particular stage and assists them to advance to the next level.

A survey study was designed and carried out by the researcher to explore the secondary level students. Students Van Hiele level and its relationship examination of mathematics. Five schools were selected from sarlahi district of Nepal by using simple random sampling method 150 students of grade x and 5 mathematics teacher from the selected schools participated in this study. Adapted version of Van Hiele geometry test (VGHT) was used as a main toll for the data collection. Students are assigned different Van Hiel levels according to their performance on VGHT. Likewise second tool was school examination in mathematics (SEM) which was meant to be constructed. Administered and scored by the teachers of the respective school. Thus student's achievement in mathematics was obtained from school's archival record. Furthermore, an interview schedule for teacher was developed to get their reflection about the VHGT.

Students performance on VHGT was analyzed and they are assigned various Van Hiele level mainly according to Usiskin (1982) "3 out of 5" modified Van Hiele level determination scheme. The result form this study indicated that many of students who participated in the research have a weak conceptual understanding of geometric concepts. 47.33%, 22%, 20%, and 10% of the total students were at the level 0 (Pre-cognition) level 1 (visual), level 2 (analysis) and level 3 (informal deduction) respectively. No students were found to be thinking at level 4 (Rigor)

The scores obtained by students on VHGT and SEM were correlated and correlation coefficient was found to be r =0.87. The result indicated that there was a significant strong

positive correlation between the advancement of the Van Hiele's level of understanding geometry and achievement in geometry. Also mathematics teacher form those participating schools expressed their unfamiliarity with Van Hiele theory. These results were found to be consistent with those of previous similar studies in UK, USA, Nigeria and South Africa.

The hierarchical nature of the Van Hiele's model has significant implication for teaching geometry. It is suggested that educators responsible for teaching geometry. It is professional in charge of teacher training programs incorporate the principle upon which the Van Hieles model is based into instructional and curricular design. The finding of this study also highlight the necessity of aligning geometry syllabus and geometry instruction with the Van Hiele levels of geometric thinking as well as the use appropriate and correct language in geometry teaching and problem solving.

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Chapter: I

Introduction

Background of the study

At the primitive time, mathematics was originated from counting and calculating by using stone and by cutting, Babylonian civilization, Roman civilization, Greek civilization, and Chinese civilization. Have well level of development in mathematics due to constructive role of mathematics. Today the world has reached in an era of science and technology. Mathematical knowledge, skills are essential to human life for superior living in the present specific technological society. As a whole, notches in pieces of stick or by tying knots in a string during these days of the ancient history of civilization, primitive human started to settle in colonies and lived social creatures, which have rise to the need of primitive counting and surveying. The history of the ancient civilization namely the Egyptian civilization, Babylonian civilization , Roman civilization ,Greek civilization , Chinese civilization have well level of development in mathematics. Due to the constructive role of mathematics. Today the world has reached in an era of science and technology. Mathematical knowledge and skills are essential to human life for superior living in the present specific and technological society. As a whole, mathematics increases the logical thinking, understanding capacity and efficiency in human being.

In the ancient period the civilized people have used mathematics to investigate shape, size and the relationship among physical objects. Ancient Egyptians used Geometry to solve their practical problems involving boundary and land areas. But with the development of mathematics the developments of Geometry is notable and prominent

.the Latin word "Mathematike" which deal with mathematical arts (Kshetri, 2068 B.S.). Mathematics is way of thinking, organizing, analyzing and synthesizing a body of data; mathematics is an organized body of knowledge in which each proposition follows as logical consequences of proves proposition or assumption. Such mathematical structure is characterized by undefined terms, assumptions and rules of logics. A major aim of mathematics is to derive a way of encouraging student's education to take one active role acquiring experience with and using the mathematical ideas and procedure that are included in the school curriculum (NCTM, 2000). Mathematics plays significant roles at all levels of the school in Nepal. With the advent of the National education system plan (1973) the importance of mathematics in the school education has been stated as follows.

"An understanding of mathematics is much more necessary for us. Mathematics improves the creativity and reasoning power. It helps us to solve our society's problem that related to school activities. Also mathematics is necessary for higher study in the field of science and technology. The mathematical concept, skill and logical reasoning are two important for us. That is only improving by the study of mathematics and it is also important for people of non-mathematical field. The mastery of mathematical concept, skill, thinking, reasoning, creativity and process was certainly increased our efficiency and effectiveness". Thus mathematics plays pivotal roles in science and technology. It said that mathematics is the bedrock of science while science is the necessary for technology in the industrial development.

In our over increasing technological world a rich study of logic and mathematical proof is fundamental for reasoning and good decision making. The study of Geometry offers students the opportunity to develop skill in reasoning and formal proof.

Additionally it helps students to describes, analyze and recognize the underlying beauty. In the structure that compose our world. Geometric thinking is a powerful tool for understanding and solving both mathematical and applied problem and offers alternate way of reasoning mathematically beyond algebra including analytical and spatial reasoning.

Geometry build on a number of key geometric topics develop in the middle grades, namely, relationship between angles, triangles, quadrilaterals, circles, and, three dimensional shapes. It is expected that students beginnings geometries are able to recognize, classify and apply properties of simple geometric shape, know and apply basic similarity and congruence theorem, understanding simple construction with compass and straight edge and find volume of basic shapes. Students studying geometry in high school, further develop analytic spatial reasoning. They apply what they know about two dimensional figures to three dimensional figures. In real world context building spatial visualization skills deepening their understanding on shapes relationship. Geometry includes a study of right angled triangle trigonometry that is developing through similarity relationship. These topics allow for many rich real world problems to help students expand geometric reasoning skill. It is critical that connection between transformation of liner and quadratic function to geometric transformation should be made. Earlier work in liner function and coordinate graphing leads into coordinate's geometry.

The study of formal logic and proof helps students to understand the axiomatic system that underlines mathematics through the representation and development of postulates, definitions and theorems. It is essential that students develop deductive

reasoning skills that can be applied to both mathematical and real world problem context throughout geometry. Students was experienced geometric thinking and reasoning techniques as accessible and powerful tools that can be used to explore the concept of mathematical as well as to model and solve real world's problems. At the core of mathematics in the early years are the numbers and geometric standards (NCTM 2000, P.77). The NCTM'S standard documents state that instructional program for grade pre-k-12 should enable all children to "Analyze characteristics and properties of two and three dimensional geometric shapes and develop mathematical argument about geometric relationship.

One activity that encourages students to describe attributes of shapes involves fabric paint or making tape to make a shape on the rug. The students are asked if they want to stand inside or outside the shape to sing a song. To get permission to stand where they choose they must answer a question such as "How do you know the shape is a triangle?" To answer correctly, the children must describe the shapes, sizes and angles. A similar activity uses shapes taped to the classroom tables. Students are called to line up by describing the shape that is taped to their table. The shapes are changed weekly. Students begin forming concept of shape long before they inter school. They may first learn to recognized shapes by their overall appearance stating, for example that a given figure is a rectangle because " It looks like a door" or they might focus on one aspect of a shape, for instance, calling a figure triangle because it is "sharp" student perform well using such thinking. For example they accurately identify circles and squares, even with "tricky" distracters. They do not do as well with rectangles and triangles but still identify

50 to 60 percent correctly. Even they often believe that squares that are not placed horizontally are no longer squares.

Geometry is considered as a tool for understanding, describing and interacting with the space. It is the most intuitive, concrete as well as reality based mathematics. The primitive form of geometry is known as Euclidean geometry which is invented by Euclid in about 300 B.C. But in 15thcentury Leonardo Da Vinci and Albert Durer found that the Euclidean geometry was unless in their painting since then dissatisfaction towards Euclidean geometry began to grow because its contents was present in readymade and prefabricated form the students. Although Euclidean geometry dominated the mathematical world for over 2000 years, at the end of 19thcentury and early part of 20th century witnessed the development of non-Euclidean geometry Euclidean geometry came to sever criticism due to the controversies that surrounded the parallel postulates. The existence of Euclidean geometry was thus threatened as mathematician showed that it was possible to create geometry other than Euclid's through which mathematical truth could be established. Despite these threats, Euclidean geometry has undergone remarkable refinement and has survived. Today it remains as core subject in mathematics curriculum around the world including Nepal.

The advocates of geometry have been under great pressure and attempt have been made not to free Euclid from logical blemish, but to replace it by a teaching strategy that is more meaningful and acceptable (cited in Shrestha, 2012). Regarding to this problem, Piaget's work was considered valuable for it tries to explain how the children's thinking develop with the growth in age. Piaget claims that a child growth is already dictated and not reversible through planned instructional technique. His theory has contributed to the

field of education by giving description to children's thinking. In terms of teaching geometry these have not been evidence over all to suggest that Piaget's theory has really became effective.

The problem regarding the teaching and learning of geometry was identified in the 1950 by to Dutch mathematics educators. Pierre Van Hiele and his wife, Dina Van Hiele - Geldof, who's due to their frustration, investigated possible reason that could have created this problem in their classrooms. The finding of their investigations resulted in the development of a theory the theory distinguishes five different thought levels that a student should go through when learning geometry. The theory was subsequently considered by many counties such as U.K., U.S.A. and The former USSR as one of the best frameworks to assess student's geometric reasoning (Atebe, 2008). This is because it provides a structure for understanding how students develop geometric concept through appropriate learning experiences (Clements and Battista, 1992). There research work was focus on level of thinking in geometry and the role of instruction in helping students move from one level to next. Dina Van Hiele - Geldof's work dealt with a didactic experiment aimed at raising students through levels. While Pierre Van Hiele formulated the structure of thought levels and principle designed to help students gain inside in to geometry.

In Nepal teaching and learning of mathematics, in primary level occupies second important place in curriculum. Moreover, it is taught as a compulsory subject from primary to secondary level. Despite this emphasis being made by the government of Nepal. Students performance in mathematics is still pour in school level, study have shown that mathematics education is largely managed and imparted through traditional

lecture method, rote memorization and cramming many students have the habit of only memorizing factual information from text book without thinking why. Worst of all the students merely copy what the teacher has the written on the bored and then memorize only that information while even neglecting their textbook. It indicates that procedural learning is more emphasized than conceptual learning from the experience of the researcher both as a teacher and students. Students often find geometry hard to learn and many teachers fear from geometry it is so because lack of confidence with teaching geometry consequently, they tend to skip this topics or "Glaze over it" in earlier grade. If teacher themselves have problem with understanding simple or basic geometric concepts then what about the students who are learning from these teachers.

In the researcher's view as a result of their poor geometric background, when these students entered the secondary phase of formal education, they were inevitable encounter problems in understanding geometric concepts. Every mathematics teacher equipped with two essential qualities. Mastery over the subject matters is teaching skills. If the teacher possesses excellent knowledge in his/her subject and fails to deliver the goods in the classrooms the entire teaching learning process ends in futile exercise. He must be thought with all the procedure and technique of arranging teaching learning.

Being a mathematics teacher with experience at secondary level the researcher learnt that although students at grade 10 levels are familiar with some of the geometric shapes they do not know their properties and they can hardly do even basic informal deductions. As a student's while studying at Bachelor level the researcher frequently wondered with the statement that how the some of the three angles of triangle exceeds to right angles and how the Euclidean and Non- Euclidean geometry can both be true.

Drawing on researcher's own experience and the finding of the reports of researcher found it appropriate to conduct a study to explore the geometric reasoning of the grade 10 students selected in secondary school in the Sarlahi district of Nepal. The difficulties encountered by students in learning geometry are not a unique problem to the particular countries. It is worldwide phenomenon.

Statement of the Problem

Geometry is one of the mother structures of mathematics and is dynamic in nature. The way of teaching and learning about geometrical concepts are one of the major problems of mathematics that is why because there is low level of an achievement in geometry such problems and issues are all over the world due to traditional teaching method. The teacher's and student's have negative attitudes towards geometrical concepts. The students have to face difficulties in learning geometrical concepts due to lack of basic concepts of geometry where as the teacher's have to faced the difficulties in teaching geometrical concepts due to lack of detailed knowledge about the topics and sufficient teaching methods.

Government of Nepal most needed to realize such type of problems and try to find the way to solve the problem. The statements of the problem are considered as follows.

- Lack of sufficient instructors or teachers to apply to Van Hiele levels of geometric thought
- Negative attitude of learners and instructors towards geometry.
- Lack of applying suitable teaching methods and materials.

Justification of the study

This study is a unique study and significant in many counts. The significance of the study is depends upon its representation the first scholarly attempt simultaneously to compare the mathematical performance of secondary school learner and teaching method in geometry classroom in Nepal using the Van Hiele level of Geometric thoughts. It is of great value if for no other reason because it furnishes a base line of comparison for subsequent studies. There is insufficient quantity of published research in which both aspect of Van Hiele level of Geometric thoughts (*i.e.* the thought levels and the instructional cycles) have be investigated in single study in context of Nepal. This study have an obligation to proof its unique and significant attributes to being the first as far as I am aware that attempts to links learn exhibited Van Hiele level of Geometric thoughts to their instructional experiences in geometric classroom in Nepal. It most quickly is acknowledged the result of being comprehensive has however added to the volume of this thesis.

In Nepalese context the teaching method uses in geometric classroom at different level is not much more suitable especially in basic level. Most of the basic level students have lack of conceptual basic knowledge about geometry and due to absence of such prior knowledge about geometry. The students of upper level are not able to learn geometric knowledge simply and finally the students went to arises some negativity about learning geometry. Here we see that the significance of teaching geometry is not positive due to different causes out of those causes the lack of experience teachers and applying suitable method of teaching geometry are significantly counted. Most of the teacher in Nepal feels difficulty in teaching geometry. Through this study we have given a short of

justification for effectiveness of Van Hiele level of Geometric thoughts for meaningful teaching and learning geometry without any hesitation. The present curriculum school mathematics curriculum in Nepal is reform oriented program. Reforms beings some contents but basically focuses more on teaching learning approaches so researcher base effective teaching learning approach or methods should be suggested for the teacher.

Furthermore one of the properties of the Van Hiele level of geometric thoughts as identified by Usiskin (1982) is its wide applicability. Despite this wide applicability only a few studies utilized the Van Hiele level of geometric thoughts to explain student's geometrics thinking level in Nepalese context as far as I could ascertain this study to apply Van Hiele level of geometric thoughts in Nepal (Oli, 2011 and Lamsal, 2005). In general there appears to be a dearth of published research in the literature concerning the use of the Van Hiele level of geometric thoughts on instruction to explicate geometry classroom instructional practice. This seeming absence makes this study a worthwhile endeavor particularly in Nepal so this study is related to find the relationship between students achievements with using Van Hiele level and without using Van Hiele level of geometric thoughts the study would have following significance.

- Van Hiele levels of geometric thoughts may help the teacher to organize their teaching learning activities sufficiently.
- The result of study has been given the mental development of the secondary level students.
- The curriculum designer and textbook writers can be following the Van Hiele level of geometric thoughts.

- The teacher training development center get an opening of a possibility of introducing the Van Hiele level of geometric thoughts in geometry teaching in Nepal. But this approach has not been in practice yet in teacher training development center.

Objectives of the study

The objectives of the study are as follows

- To explore an impact of Van Hiele's approach in teaching geometry (Quadrilateral and circle) at secondary level.
- To find the correlation between an achievements Van Hiele geometric test (VHGT) school examination of mathematics (SEM).

Hypothesis of the Study

a. Research Hypothesis

The research hypothesis formulated for the study is as follows

- There is significant difference between achievement in teaching Quadrilateral and circle to secondary level students through Van Hiele model and conventional teaching method.
- Statistical Hypothesis

H_0: $r = 0$ (Null hypothesis)

H_1: $r \neq 0$ (alternative hypothesis)

Where r represent coefficient of correlation of student's achievement of Van Hiele approach and conventional method of teaching geometry

Limitation of Study

This study only represent portraits of selected learner's mathematical performance and of teaching method in geometry classroom particular in secondary school of Nepal based on the Van Hiele model. It does not claim to have captured and related the entire story about learner's Van Hiele geometry thinking levels, nor does it purport to discuss instructional practices that represent the whole educational landscapes of the country concerned consequently as is typical with case studies, caution should be exercised in extrapolating and generalizing from the finding of the study given in the dept descriptions of the cause treated in this study it is hoped that many of the result obtained in the research was resonate in similar context.

Definition of related terms

Van Hiele level: According to Van Hiele level of geometric though all those geometric learners are progressed their geometric knowledge by the help of five levels visual, analysis, informal deduction, deduction and rigor of Van Hiele model.

Students: Students refer to secondary level students.

Achievement: The word achievement in this study is defined in terms of the magnitude of score obtained by the students in the school examination in mathematic that has been administered by school.

Conventional teaching approach: The Conventional teaching approach is defined as the approach without using Van Hiele approach.

Chapter: 2

Review of Related Literature

The review of relate literature refers to the conclusive study of those literature that support us in our research. In the course of searching for relevant literature to support this researcher thesis. I found it convenient to distinguish among three broad categories of studies geometry in school mathematics education are as follows.

- That concern with formulation of learning theories. For Example Piaget and Inheldar (1969), Van Hiele (1986)
- Those that focus on theories verification, for example Hoffer (1981), Usiskin (1982), Burger and Shaughnessy (1996), Fuys (1988)
- Those that deals with the application of theories, for example may berry (18983), Shaughnessy and Burger (1985), Senk(1989), Fezza and Webb(2005).

It should however, be noted that these three categories implicitly on to account first there are benefits to obtained from applying a theory in a particular context through and invention program the result of such an application could yield in sight enabling improvement of the status, secondly during the application of theory in a given context. For the insight about the phenomenon being studied could be gained who is can then inform either a refinement of the existing theory or the formulation of a new theory. In these third categories educational studies are mentioned. Since very few studies have utilized Van Hiele's model of geometric thinking in Nepal.

Geometry is science which deals shape size and position of figures. It is best on definition, axioms and postulates these granted all the rest follows by pure reasoning.

Considering the difficulties associated with any attempt to define a concept (Orton, 2004) and the fact that the most concepts are better understood through listing of a few examples, one might wished conclude that providing such a definition is not necessary (Van Hiele, 1986).This is particularly true on the concept on the geometry given its sheer extent as field of mathematical study. In order to give this study a sharp focus and to provide common ground for the understanding among various readers of the concept of geometry and it relates this study .I deem it expedient to to examine a few definition of geometry.

Borowskin and Borwein(1989.p246) conceptualize geometry as "The elementary study of properties and relations of CONSTRUCTIBLE (emphasis in the original) plane figures" It is the specific mathematical axiomatization of the properties and relation of plane shape as studied. For example under Euclidean geometry an aspect this thesis utilize Borowskin and Borwein's notion of geometry by exploring through geometrical construction students understanding of the properties and relation of simple geometrical shape, like triangles, squares, rectangles, rhombus, trapeziums and circles.

Pandit(1999) on his master thesis entitled "A study of attitude of secondary level students and teachers toward geometry" there were four major objectives and he select fifteen teachers and two hundred and twenty four students from Tanhun district concluded that.

- The students studying in secondary level has a positive attitude toward geometry
- The teachers had negative attitude towards secondary level geometry.

- The secondary level boys had better attitudes than those of girl's attitudes towards geometry
- The mean attitudes score of students towards geometry was significantly greater than that of their teachers.

Fuys Geddes and Tischler (1988) pointed out that a student has to go through the levels consecutively otherwise he/she was not be able to perform the task they agreed that it was important to follow the order of the Van Hiele theory's levels in geometry they further concluded that each level has its own linguistic symbol with its own systems of relations.

Sank (1989) examined the relationship between the achievements in writing geometry proof and the Van Hiele levels. For that purpose she revisited the cognitive development and achievement in secondary school geometry (CDASSG) on which Usiskin(1982) had previously worked her study reached the conclusion that there was a positive relationship between high school students achievement in writing geometry proof and Van Hiele levels of geometric thought.

Amatya (2000) conducted a study in mathematics education entitled "The effectiveness of the use of instruction materials on the achievement of students in mathematics" He concluded that the achievement of students taught with the use of instructional materials was higher than the achievement of students taught by without use of instructional materials.

Similarly, in a study entitled "attitude of ninth grade students toward geometry and its relation with their achievement; A study of Morang district by Bhattrai(2000) with the aims to identify the status of attitudes of grade 9th students in geometry with their

status of attitude towards their subjects. He selected hundred students from four schools. He developed and achievement test and attitude scale. He applied t - test and conclude boys achievement status was found to be better than girls in geometry and students from urban performed better than the students from rural. He also concludes that his significant relationship was found to be existed between student's attitude status and achievement status towards geometry.

Pusey (2003) carried out a thesis entitled " The Van Hiele model of reasoning in geometry ; A literature review the objectives of the study were to describe the Van Hiele model in more detailed, present research, present research related to Van Hiele model to other theoretical model and discuss classroom implication. His research was highlighted for different areas with respect to Van Hiele model.

- Appropriate way to assess student's level of geometric reasoning and result of those assessments.
- Assessment of pre- service and in- service teacher's level of reasoning.
- Instructional intervention used with students best on the Van Hiele Model.
- Intervention with both pre- services and in - services teacher to promote awareness of this theory and improved knowledge of geometric contents.

He found in his that there were three broad categories of research done in Van Hiele model. The first core model avenue of research has focused on testing the Van Hiele Theory itself and assumption. A second avenue has to find appropriate ways to assess the level and discussed implication of this assessment. A third avenue of research with the Van Hiele theory has looked at the effect of intervention with students and

teacher based on the model. With students the research has sought to determine if instruction based on Van Hiele recommendation is effective in fostering improved reasoning.

Lamsal (2005) conducted a study on "A study on the effectiveness of van Hiele's approach in teaching geometry at lower secondary level" aimed to exploring the effectiveness of the Van Hiele's approach in teaching geometry. The population of this study was eight grade students enrolled in public school in Syanja district. He experimented on the forty nine pupils of the sample with the help of teaching module as a research tool. In his study he found that mean achievement score of the students taught by Van Hiele approach was higher than that of taught by conventional approach.

Atebe(2008) conducted hi Ph.D. dissertation entitled "Student's Van Hiele level of geometric thought and conception in plane geometry : A collective case study of Nigeria and south Africa" with the objective to explore and explicate the Van Hiele level of geometric thinking of a selected group of grade 10, 11, 12 learners in Nigeria and south African school and to provide a rich and in-depth description of geometric instructional practice that possibly contributed to the level of geometric conceptualization exhibited by this cohort of higher students learner. For this collective study he took a total of 144 mathematics learners and six mathematics teachers from Nigeria and South Africa selected by purposively and stratified sampling. He used Usiskin' test interview, classroom video and hands on activities to collect the data his study revealed that

- Most of the teachers were not yet ready for the formal deduction study of school geometry. Only 2% or 3% of them were respectively at Van Hiele level 3 and 4.

- His research related to gender difference in performance generally favored the main learners.
- Furthermore, His study showed that learner Val Hiele level strongly correlate with their performance to geometry content test and Mathematics generally, for $n \geq 2$ learners at Van Hiele Level 'n' obtained higher means on nearly all the test administered in his study then their peers at level n-1.

Gyawali(2009) did a thesis entitled "Effectiveness of Van Hiele approach in teaching Geometry at secondary level." He selected the sample consisting of 40 students purposively from Nawalparasi district. He taught the experimental group by employing Van Hiele approach and the control group by conventional approach. His result also revealed that the mean score of the students of the experimental group was greater than that of the control group thus he concluded that Van Hiele approach is effective in teaching Geometry than the conventional approach.

Thus recapitulating this literature Van Hiele first purposed his theory in 1957 A.D. Much research has been done to questions and validated Van Hiele theory since its initial introduction. Researchers have trait to determine whether Van Hiele model is accurate in describing geometric reasoning and if a student's reasons consistently across topics within geometry. Research has also attempted to validated if Van Hiele level are discrete and from a hierarchy. Some have questioned the existence of precognition level more basic then visualization level efforts have been made to inform teacher of the theory as well as suggest strategies for how it might impact classroom instruction .some researchers objectives have been to identify these level of reasoning and discrete instrument to assess the Van Hiele levels other have done studies in the classroom and

looked at how Van Hiele levels are related to students achievement and whether they are able to predict success in geometry.

Theoretical Framework of the Study

The new project math courses were examined in there entirely in the junior and leaving certificate of 2015 and 2014 respectively (Cosgrove, Perkins, Shiel, Fish and Mc Guinness, 2012). The new course present significant change in both subject contain and pedagogy with teachers of mathematics attending ten full day workshops over a five year period (PMDT, 2016)" one of the key elements of project math is a greater emphasis on an investigative approach, meaning that students become active participants in developing their mathematical knowledge and skills. This implies nit only change in the contains of the syllabus but also and more fundamentally perhaps, change to teaching and learning approaches".

The Van Hiele Model for the teaching and learning of geometry has its origin in separate doctoral dissertations by Pierre Marie Van Hiele and his wife Dina Van Hiele Geldof submitted to the University of Utrecht in 1957(Van Hiele 1957, and Van Hiele - Geldof 1957). Dina died soon after her thesis and it was left her husband to explain and develop the theory in the three paper written between 1958 and 1959(Usiskin, 1982). Van Hiele believes that the learning process leading to complete understanding at next higher level has five phases approximately but not strictly sequential entitled "inquiry directed orientation, explanation, free orientation, integration(Usiskin,1982) Gutierrez(2007) have describe these phase. Van Hiele model suggest that geometrical thinking has five closely related stages. Most of the geometrical thinking studies have been carried out by talking this model as the basic. Van Hiele model was formed to improve geometrical

comprehension and this model was developed in classroom setting. In this model student should join the activities and find out the characteristics of geometrical concept. The most important characteristics of Van Hiele model are that it explains the development of geometrical thinking process with five related stages. Each of these stages determined the thinking process that are necessary for finding geometrical relations out these stages defined the process of thinking and the types of geometrical ideas rather than the amount of the data geometrical thinking stages proposed by Van Hiele model are(Olkumve Toluk,2003: Van de Walle,2004) visual period(level,0),analytic (level 1),informal deduction (level 2), formal deduction (level 3),and rigor (level 4) these stages determined by Van Hiele model explain the geometrical thinking skills of students and they are useful for classroom application.

Van Hiele levels of geometric thinking in two different numbering schemes are used in the literature to identify Van level of thinking (Senk. p.310). The Val Hiele originally referred at levels 0-4, however, when Wirszup and Hoffer bought the work of the Van Hiele t the attention of the American audience, they used 1 to 5 numbering scheme This numbering scheme allow the researcher to use level 0 for students who do not function at what the Van Hiele referred to as the ground or basic level. In this study the Van Hiele level are discussed using the categories 1- 5 used by Mateya (2008) and Atebe (2008). According to OlkumveToluk; 2003 and Van De Walle; 2004, Van Hiele level of geometric thinking are as follows.

Level 0: Visualization (Basic visualization or Recognition)

At this level pupils use visual perception and nonverbal thinking. They recognized geometric figures by their shape as "A Whole" and

compare the figures with their prototypes or everyday things ("It look like a door") categories them ("It is/not a ……..") they use simple language they do not identify the properties of geometric figures.

Level 1: Analysis (Description)

At this level pupils (students) start analyzing and naming properties of geometric figures. They do not see relationship between properties, they think all properties are important (= there is no difference between necessary and sufficient properties). They do not see a need for proof of facts discovered empirically. They can measure, fold and cut paper, use geometrical software.

Level 2: Abstraction (Informal Deduction or Ordering or Relational)

At this level pupils or students perceive relationship between properties and figures. They create meaningful definitions. They are able to give simple arguments to justify their reasoning. They can draw logical maps and diagrams. They use sketches, Grid paper, and geometrical software.

Pierre Van Hiele wrote "My experience as teacher of geometry convinces me that all too often students have not at achieved this level of informal deduction. Consequently, they are not successful in their study of the kind of geometry that Euclid created which involved formal deduction".

Level 3: Deduction (Formal deduction)

At this level students can give deductive geometric proof they are able to differentiate between necessary and sufficient condition. They identify which properties are implied by others. They understand the role of definition, theorems, axioms and proof

Level 4: Rigor

At these level students understands the way how mathematical systems are established. They are able to use all types of proof they comprehend Euclidean and non-Euclidean geometry. They are able to describe the effect of adding or removing an axiom on a given geometric system.

Properties of level of Van Hiele model

The Van Hiele levels of geometric thought have five important properties.

Property 1: Fixed sequence (order)

A student cannot be at level N without having gone through level N-1. Therefore, the student must go through the levels in order.

Property 2: Adjacency

At each level what was intrinsic in the preceding levels becomes intrinsic in the current level.

Property 3: Distinction

Each level has its own linguistic symbols and its own network of relationship connecting those symbols. The meaning of a linguistic symbol is more than its explicit definition, it include the experiences which the speaker associate with the

given symbol. What may be correct at one level is not necessarily correct at other levels.

Property 4: separation

Two persons at different levels cannot understand each other. The teacher speaks a different "language" to the student at a lower level. The Van Hiele though this property was one of the main reason for failure in geometry.

Property 5: Attainment

The learning process leading to complete understanding at the next level have five phases information, guided orientation, explanation, free orientation and integration which are approximately not strictly sequential.

Five Phases of Learning Process

Van Hiele believes that cognitive progress in geometry can be accelerated by instruction. The progress from one level to next one is more dependent upon instruction than an age or maturity. They gave clear explanation of how the teacher should process to guide students from one level to next one.

Phase 1: Information or inquiry

Student gets the material and start discovering its structure. The teacher holds a conversation with the pupils in well-known language symbols in which the context he wants to use becomes clear (A teacher might say "this is a rhombus construct some more rhombus on your paper").

Phase 2: Guided or directed orientation

Student deals with the task which helps them to explore implicit relationships. The teacher suggests activities that enable students to recognize the properties of

the new concept. The relation belonging to the context are discovered and discussed (A teacher might ask "what happens when you cutout and fold the rhombus along a diagonal? Along the other diagonal? ")

Phase 3: Explanation or explication

Student formulates what they have discovered and new terminology is introduced, they share their opinions on the relationships they have discovered in the activity. The teacher makes sure that the correct technical language is developed and used. The Van Hiele thought it is more useful to learn terminology after students have had an opportunity to become familiar with the concept (A teacher might say "here are properties we have notice and some associated terminology for the things you have discovered. Let's discuss what these mean the diagonal lies on the line of symmetry. There are two lines of symmetry. The opposite angles are congruent. The diagonal bisect the vertex angles.")

Phase 4: Free orientation

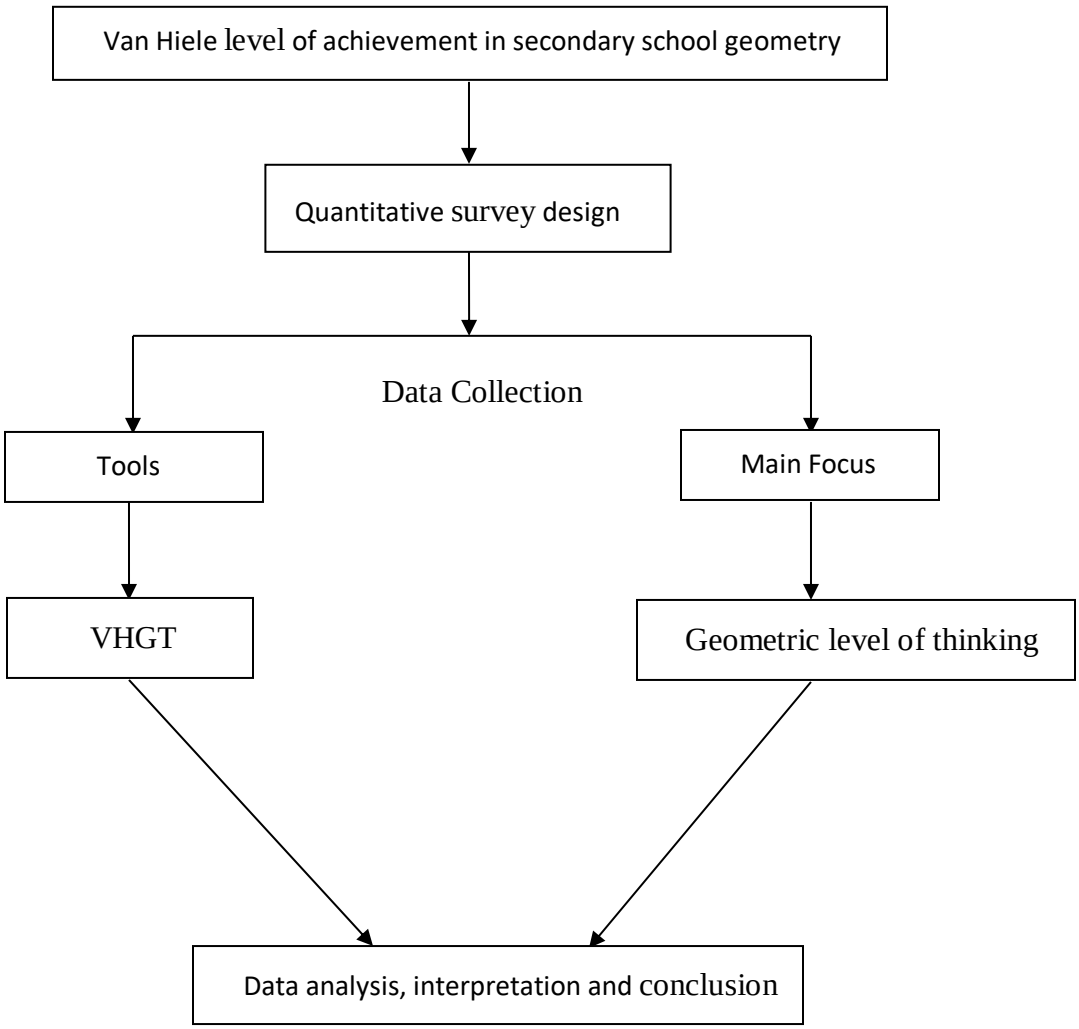
Student solve more complex task independently. It brings them to master the network of the relationship in the materials. They know the properties been studied but they need to develop understanding of relationship in various situation. This type of activities is much more open- ended (a teacher might say " how could you construct a rhombus given only two of its sides? And other problem for which student have not learned fixed procedure")

Phase 5: Integration

Students summarize what they have learned and keep it in mind the teacher should give to the student an overview of everything they have learned. It is

important that the teacher does not present any new material during this phase but only a summary of what has already been learn. (A teacher might say "here is a summary of what we have learned write this in their notebook and do these exercises for homework").

Conceptual Framework



Chapter 3

Methods and Procedure

This chapter specially considers the methodology and procedure which are used in study. The main goal of the study represent to explore the students Van Hiele level of geometric thoughts and its relationship with their achievement in mathematics and the procedure of study which carried out to achieve the objective of the study and found out the answer of the research questions it also explain about design of the study sample and method of sampling, tools and data collection procedure and data analysis.

Research Design

The research design is survey design type focusing on total 150 students from to high school of Sarlahi District of Nepal. The study is carried out in natural school setting of the participants of secondary level. I interacted with the research participants in their respective classroom and explore their geometric understanding in relation to Van Hiele level of geometric thoughts.

Population of the Study

This study was conduct at secondary school of Sarlahi District of which is also the home district of researcher. There are all together 100 secondary school running at the reference period. The population of the study consist all the students enrolled in Grade 10 of government School in 2077 B.S. in Sarlahi District.

Sample of the Study

Since the collective case study was carry out on the basis of sample. The sample related to the study was select from Sarlahi District by stratified random sampling method to obtain true representative of the population; sampling is the process of

selecting some units from population on some predetermined basis. The researcher first collects the complete list of secondary school district education office of Sarlahi. And then total school was divided into different strata according as urban and rural areas one private school and one government were select from the urban area. Furthermore the rural area was geography divided into four strata Northern, Southern, Eastern and western part of the district, one secondary level school from each part was be selected randomly by using simple random sampling. All the students of the grade 10 who was be available at the visiting time constituted in the sample of study.

Tools for Data Collection

A research tool is very important things for collecting data in this study following tools was be use for data collection.

- **Van Hiele Geometric Test (VHGT)**

Construction, grading and administration of VHGT

Construction: VHGT is the main data collection tool of this study for collecting data which was adapted from the CDASSG test used by Usiskin (1982) VHGT was originally develop by the staff of CDASSG (Cognitive development achievement in secondary school geometry). Project Usiskin (1982) for assessing student's Van Hiele Level of geometric reasoning. This test was consisting 25 multiple choice question with for purposed answer per question and five questions are of each level of Van Hiele model. According to Usiskin (1982) the item was return to cross pond directly to statement from the Van Hiele about characteristics behaviors students' exhibit at each level.

However the researcher of this study use only first twenty items that characterized the first four Van Hiele level.

Test Grading: Two grading method was apply for the purpose grading students in Van Hiele level of geometric thought. In first grading method each correct response is the 20 question multiple choice test was assign 1 point hence each students scoring range was be 0 to 20 marks. Similarly the second method of grading Van Hiele level of geometric thoughts was base on the "3 of 5 correct" Success criteria suggested area by Usiskin (1982). By this criteria if a student answered correctly at least 3 out 5 item in any of the level then the students was be consider to have complete that level.

Test Administration: This test administration was mean to be answered by all learners who participated in the study. The learner was provided their answer of the VHGT on multiple choice answer sheets. Pilot testing was indicate that VHGT. This VHGT can be complete in thirty minutes therefore thirty minutes was allow the learners to complete the VHGT. Thus the Van Hiele level of geometric thought was administer by the researcher himself by visiting each participating school with the help of the mathematics teachers of the respective school.

Achievement test

All Schools continuously assess the student's performance. Thus achievement test refers to school examination in mathematics (SEM). This test was constructed, administered by the teachers of respective school. Students score in SEM was obtained from schools record as a secondary data.

Validity

To validate the measurement instruments. I consulted the geometry curriculum as well as the textbook for the learner participants. The purpose was to gain insight into what the learners were expected to learn so that I could develop my instruments accordingly. The main focus of this study was to explore and explicate the impact of Van Hiele levels of geometric understanding of the learners of secondary schools. Thus, only questions on students understanding of geometry were asked. Zeller state that establishing content validity " involves specifying the domain of content for the concept and selecting indicants that represents the domain of content " After constructing the test items I consulted five mathematics teachers form each selected schools to crosscheck the items . 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 research were checked for validity. The documents analyzed were found to be valid because they were all consistent with the Nepalese education system. The Van Hiele geometric test was first developed by Usiskin (1982) to test the geometric reasoning of the American students. Atebe (2008) adapted this test for their study with the Nigerian and South African students. This study is similar to those of Usiskin (1982) and Atebe (2008). Therefore, the researcher utilized the adapted test as it was based on. The mathematics curriculum of Nigeria and South Africa, the researcher piloted it in order to check for its suitability in the Nepalese context

To further ensure that the contents choose were within the prescribed domain of study from the learners concerned. I administered a teacher questionnaire which ague the teachers the chance to crosscheck and contribute to the geometry content areas that tested in this study. Their response indicated that the contents examined in this study reflected

the prescribed geometry contents for the learners piloting the text instruments also helped to refine them. since research interpretation and conclusions that are built upon triangulation are claimed to stronger and more believable than those that rest primarily on the narrow framework of a single me method-I strengthened the result of this study by using data from different sources. The hands-on activity test and the pen-and paper tests were different methods of gathering data that helped to explain student's Van Hiele levels of geometric understanding. This refers to a methodological triangulation and explains as a researcher's use of different method to gather data about the same object of a study to ensure validity.

Reliability

Reliability is the degree to which a test consistency is measured. The repeated administration of the test is essentially same then we can have that the score obtained from the test is confidently more reliable. Thus reliability refers to the consistency of the results. There are many different ways of determining the reliability of a measuring the results in educational research. These include test –retest reliability, the split-half method and internal consistency but this research is based on the correlation between the students Van Hiele levels of geometric thought and school examination of so to measure the reliability of this study the probable error of correlation coefficient was used which was found as P.E (r) = 0.023, this implies that the test is consistent that is why because six times of reliability coefficient is greater than of the correlation coefficient.

Data collection procedure

The researcher himself visited each participating schools and explained the purpose of this study with the head teachers and then take permission for the

administration of the VHGT. Having got the permission from the school, special arrangement was made for the administration of the test and students were prepared for the test. Coincidently, it was the time when students were preparing for their upcoming SEE examination. Each school was visited and VHGT was administered. All possible attempts were made to create conducive environment both as psychologically and physically so that students exhibit their best performance in the test students score in mathematics was obtained from the participating schools document. In addition, the mathematics teachers of the corresponding school were involved directly in the administration of the VHGT. They were asked to observe the items of that test. Finally, they were interviewed to obtain their reflection about the test. After collecting the answer sheet's of the student's from each school. They were first carefully checked to examine whether students have wrote correctly. Each copy was graded carefully by researcher himself and scored according to prepared marking scheme. Then all the score was transcribed in to computer. Al possible was taken while entering the data in the computer program Microsoft word 2007. So the error would not occur.

Data Analysis Procedure

After the data had been collected they were thoroughly examined, recorded and tabulated in computer program Microsoft word 2007. The data were analyzed and interpreted by using simple statistical technique. Students score in each VH level was added to obtain the total raw score and then it was converted into percentages score for the simplicity of the comparison. Mean was used to find the level wise mean score of the students in the VHGT and SEM furthermore, percentage number of students in each van

Hiele level was computed after that percentage number of students was interpreted in terms of their corresponding Van Hiele level.

Karl Pearson's coefficient of correlation was used to find the relationship between students Van Hiele level of geometric thought and their achievement in school examination of mathematics. For these purpose students score in VHGT was correlated with their score in SEM. The researcher consider only the score of those students who were classified into different Van Hiele levels as the relation was desired between Van Hiele level and achievement in mathematics. Also the students who were functioning at pre-recognition level were not taken in to account for the calculation for their VH score was 'O'. In order to test the significance of the coefficient of correlation, probable error of correlation coefficient i.e. P.E (r) was found and interpreted, furthermore the data obtained from teacher interview were analyzed and interpreted in the light of Van Hiele theory.

Chapter- 4

Analysis and Interpretation of the Data

This research design was is of collective case study type focusing on 150 students from high school of Sarlahi district. Its main objective was to explore the students van Hiele levels of geometric thought and to find out its relationship with their achievement in geometry. It employed both primary and secondary data which are collected from the field in the form of test score and utilized both quantitative and qualitative analysis

This chapter refers to analysis and interpretation of the data. This study employed both descriptive and international data analysis. The data obtained from school examination (SEM) and van Hiele geometric test (VHGT) were collected, tabulated and analyzed. The data collected from SE are considered as secondary data and the data collected through VHGT are considered as primary data. The collected were analyzed under the following heading.

- student's van Hiele level of geometry thought
- correlation between the student van Hiele level of geometric thought and their achievement in mathematics
- Teacher reflection about the VGHT

Student's van Hiele level of geometric thought student's performance on VHGT has been given in appendix-G. Their score on VHGT was analyzed in order to determine the number and percentage of students at each van Hiele level according to the modified van Hiele level classification assignment methods. The 3 of 5 correct success criterions was used in classification methods. The result is summarized in the

Table 4.1

Table 4.1: Number of students at each VH level on geometric reasoning.

Table 4.1

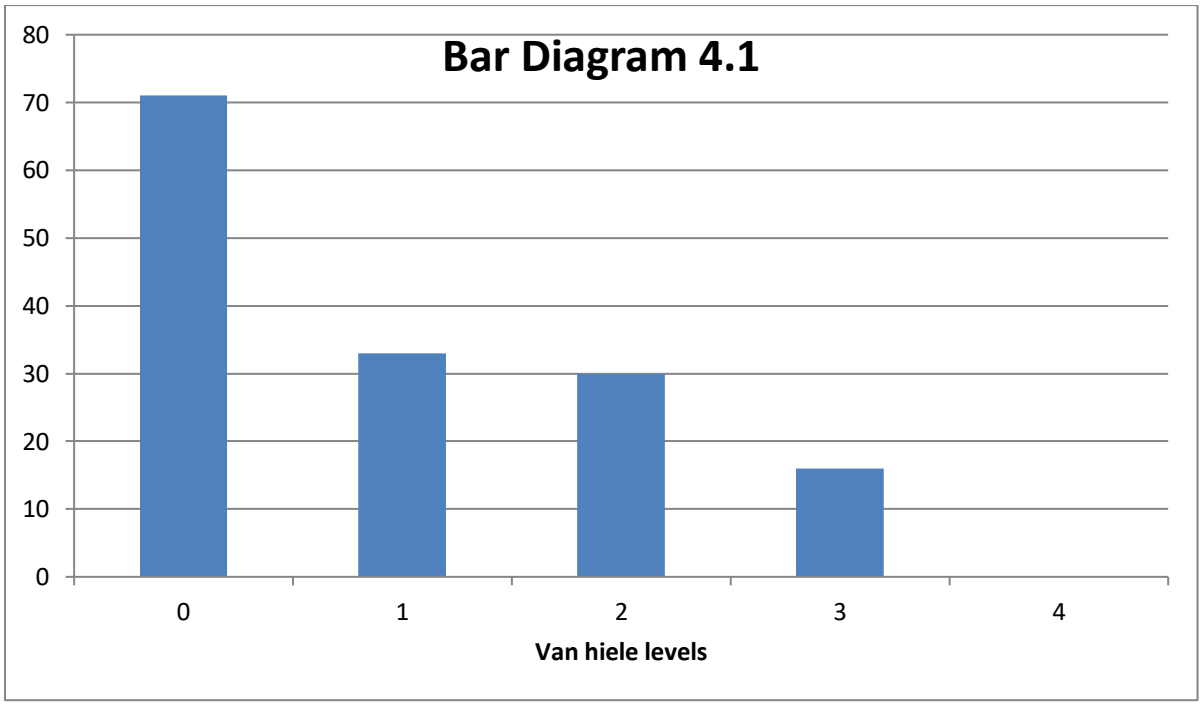
VH level	No of student	Percentage
0	71	47.33
1	33	22
2	30	20
3	16	10.66
4	0	0
Total	150	100

Table 4.1 shows that 47.33% students out of 150 are at visualization that means at Van Hiele level. This implies that 150 students are able to use visual perception and non-verbal thinking they recognized geometric figures by their shape, the second 22% students is at VH. Level 1 this implies that 33 students are start analyzing and naming properties of geometric figures. But not see relationship between properties they think all properties are of equal importance. The proof of the properties is not needed. The third 20% of the students are at VH. Level 2 that means are at abstraction or informal deduction or ordering or relational. This implies that 30 students are able to perceive relationship between properties and figures, create meaningful definition, able to give simple argument to justify their reasoning and can draw logical maps and diagrams. The last 10.66% students are at VH Level 3 that means at deduction or formal deduction

level. This implies that the students are able to give deductive geometric proof, able to differentiate between necessary and sufficient condition and can also identity which properties are implied by another

Furthermore, the table 4.1 shows that 120 students attain the fourth Van Hiele level. In other words, there are no students reasoning at deduction level. This fact suggest that even some students construct a formal proof of a theorem they do not understands it well it justifies that the secondary level 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 in the way of establishing geometric theorems with in an axiomatic system.

Similarly, table 4.1 indicates that using the modified van Hiele level assignment scheme, a total of 150 students (100%) were assigned to various van Hiele level



Above bar diagram shows that the numbers of students performance table at different van Hiele levels. The shows that each and every students cross the van Hiele

level 0 and level 1 that means visualization and analysis this implies that all students can have visual perception, non-verbal thinking and they start analyzing and naming properties of geometric figures.

Correlation between the students Van Hiele level of geometric thought and school examination of mathematics

This section is concern with the determination of the possible relationship that exists between van Hiele levels of geometric thought and an achievement of participants in school examination of mathematics. This relationship was found by using karl person correlation coefficient between raw score of van Hiele which was converted into percentages and scores of students obtained in sem. In the way of determination of correlation coefficient 150 students of class 10 was included from five different secondary school of Sarlahi district and from each school 30 student's was sampled by simple random sampling method. The determination of correlation coefficient between VHGT and SEM was included only 30 items out of 150 which was selected by linear systematic sampling method. The value of items corresponding to VHGT and SEM are represented by random variable X and Y.

An analytical computation of the random variable X and Y whose corresponding value was obtained by students in VHGT and SEM was carried out numerically by using product moment curried out numerically by using product moment correlation which is also known as Karl person's correlation coefficient .

The correlation coefficient was found to be r_{xy}= 0.87 Hence it can be concluded that there is highly positive correlation between X and Y that means. Between VHGT and SEM. the computation of correlation coefficient has been given in the appendix

Table 4.2 Number of students in each van Hiele level and in SEM with their percentage means scores.

VH	No. of student	% mean score in VHGT	% mean score in SEM
0	71	47	50
1	33	22	20
2	30	20	18
3	16	11	12
4	0	0	0

Table 4.2 show that percentage means score of the 71 students in VHGT who were at 'O' VH level visualization is 47 similarly the mean scores of the students in VHGT who were at the level 1,2,3 and 4 are 22%, 20%, 11% and 0% respectively. This implies that with the increase of the van Hiele level of students their scores in SEM also increase. This the positive correlation between VHGT and students scores in mathematics ier$_{xy}$=0.87 indicates that there was a relationship between achievement in geometry and advancement in the van Hiele's level of understanding geometry.

In an order to order to ascertain the reliability of the value of pearsonian coefficient of correlation, probable error of correlation coefficient P.E (r) (see appendix-D) i.e. P.E (r) = 0.023 since the calculated value of correlation coefficient r_{xy}= 0.87 is greater than six times of P.E (r) thus r is definitely significant which conclude that null hypothesis was

rejected and the alternative hypothesis was accepted. That means there is strong correlation between the students VHGT and SEM.

Teachers Reflection about VHGT.

Teachers are considered the most responsible and pivotal agent in teaching learning activities. Teacher's knowledge about subject matter, leaching method, and tearing theories are crucial tractors for enhancing student's learning. There were five teachers interviewed in this study among the entire teacher four are male and one was female. All of them were trained in mathematics teaching but none of them had any special training in teaching geometry.

In the response of question number 1 and 2 teachers training about mathematics. But only two teachers had got an opportunity to participants in teaching training. (Q.N1 how long have you been teaching mathematics? Q.N 2 Have you had any training in teaching Geometry?

In the response to Qn. 3 which was about theoretical framework of van Hiele made. (Do you familiar about van Hiele model of geometric thought?) And only one teacher's of shree sarasawati secondary school Hajariya -3 barahathawa, expressed their familiarity of van Hiele's model of geometric thought.

Similarly, in the response to Q.N 4 which was about the problem that encountered in teaching geometry. (What kind of problem do you encounter during teaching geometry) all of the teachers said that they faced problems in the deductive proof and construction of geometrical figure

In the response to Q.N.5 which was about family back ground of the students related to intellectuality (Do you think that students studying at secondary level comes from lower

classes with rich experience in geometry) most of the teacher's said that many more students of secondary level comes from lower classes without sufficient experience in geometry and they also said that secondary level student did not have foundation of geometry.

In response to Q.N 6 what was about noticeable comparison of VHGT and SEM. (What different things did you notice through comparison of VHGT and SEM?) They said that the VHGT was objective type test having four alternative for each question and the level of difficulty increase respectively from level 0 to 4 some teachers said all the question are related to quadrilaterals of the answer are seemed to be correct.

In sum VHGT was somehow different to them and they were quite unknown to the van Hiele theory.

Chapter – 5

Summary, Finding, Conclusion and Implication

This chapter represents the presentation of the summary. Finding the conclusions of the study and implication for the further study.

Summary

As started in chapter iii this study was of survey design study type armed at investigating the secondary level student's Van Hiele level of geometric thought and exploring its relationship with the achievement in school examination of mathematics. In order to achieve these objectives the researcher was selected five schools from sarlahi district of Nepal by using convenience sampling method. The total of 150 students was included including 30 students from each school. in order to asses students van Hiele level, adopted version of VHGT developed by the staff the cognitive development and achievement in secondary school geometry (CDASSG) project was employed as a main research tool. This test was administered by visiting each school by them researcher by himself with the cooperation of the teacher of the participating school. In addition, scores in SEM of those students who appeared in VHGT was obtained from me respective schools record. Then the score obtained by these students was analyzed and obtained the following finding

Finding of the study

By the analysis and interpretation of the date obtained from VHGT and SEM that has been described in chapter IV, the following finding was drawn.

- An overall percentage mean score of 53 % obtained by the participating students in VHGT was regarded as evidence that the majority of the learners in this study were at low van Hiele geometric thinking level (Level 0,1,2,3 and 4)
- The result of this study indicated that the majority of the students who took the VHGT were at level 0 on the van Hiele geometric scale which means that their knowledge of school geometry was poor.
- The result of this study indicated that only 16% of the students are at level 2 and 3 this implies that only 16% of the students are able to reach the level 4 of VHGT.
- These result in addition to providing support for the rank order properties of the van Hiele level also indicated that students in this study was faced more difficulties with geometric problem at level 3 which was found only 11% of total.
- Student's VHGT scores were found to be significantly correlated with their SEM scores that mean there is highly positive correlation coefficient between VHGT and SEM. In other words there is strong relationship between VHGT and SEM.

Conclusion

This study concluded that students of grade 10 were not sufficiently prepared to understand the concept of geometry as the most of the student on this study were below the van Hiele level 2 therefore, majority of the students have poor conceptual understanding in geometry possibly due to their imposes in mechanical and procedural learning. The other conclusion was that there is highly position relationship between performance in van Hiele geometric test and school examination of mathematics thus the poor performance of more students more students on mathematics was strongly

associated with being at lower van Hiele levels. So the student's level of thinking plays a very important role in the learning of whole mathematics furthermore, this study supports that level of reasoning in geometry are sequential. 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 the van Hiele theory is one of the best frameworks in exploring student's geometric reasoning.

Implication

The implication and tentative recommendations resulting from thesis study are as follows.

- Since the greater portion of the students in the study was found to operating in low van Hiele level, it is imperative to promote such classroom activities in classroom which helps students increase their level of geometric thinking. This study confirms the need geometric instruction before secondary level.
- Many students in this study were able to recognize shapes only in some standard orientation. Teacher need to provide students with plenty of opportunities for exploring the properties of simple geometric shapes in different orientation. During these activities, the invariant properties of the shape should be emphasized.
- The findings that the students van Hiele levels correlate significantly with their mathematical performance in general have an important implication for teacher's daily classroom practices. For teacher to be aware of the levels of thinking that characterized each of the Van Hiele levels may helps to minimize the mismatch between their teaching methods and learners cognitive thinking level. In particular

teachers familiarity with the instructional cycle of the van Hiele learning phases should more effective their effort to assist learners makes progress with their learning.

- Teacher training centers and other intuitions that are responsible for preparing the school mathematics teachers need to impart the knowledge about van Hiele theory to the mathematics teachers.

- Since the van Hiele theory forms the foundation of mathematics curriculum for country such as USA Britain, Netherlands, Russia etc (Mateya, 9,106) it is recommended that Nepalese mathematics curriculum should also align itself with the van Hiele theory.

Suggestion for the further Study

Given the research is originality, and absence of precedent, its finding can at best only be regarded as tentative Hence further research may be needed to add reliability to the results of this initiative The following suggestions are made for father study.

- Study by using different teaching and learning modules should be carried out, so that these modules when came out effectively can be used in classroom teaching, could be an easiest way of introducing reform in geometry teaching.
- This study was confined only to sarlahi district of Nepal. Therefore father studies should be done indifferent districts of Nepal or any where through all over the world and the result of the study can be generalized similarly this study has not answered whether the conventional teaching method is suitable for minimizing the generic difference in achievement due to the level of quality of the research design. So this the

level of quality of the research designs. So this study is needed to claim the authenticity of the effectiveness of the van Hiele level of geometric thought.

- It would be worthwhile to study the opinions and attitudes of teachers and students toward the use of van Heile level of geometric thought with teaching module.
- Similar studies may be carried out at each grade level of schooling in order to have a wider view of effectiveness of van Hiele level of geometric thought in school level mathematics.

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APPENDIX – A

Consent Letter to the principals/ Head teachers

Universities Campus Kirtipur

Date:

Dear Sir,

Subject: Seeking for help & Permission.

I am a student of M. Ed. Fourth Semister Studying at the University Campus (T.U.) Kirtipur. I am undertaking a thesis on the topics **"Van Hiele Levels and achievement in secondary school geometry a case study in Sarlahi district."** So, I am required to write a research report. I am primarily concerned about assessing the student's Van Hiele level of geometric reasoning and exploring the possible relationship between the student's Van Hiele levels and their achievement in school in examination of mathematic (SEM). For this purpose I have intended to administer the standardized Van Hiele geometry test on our students in Nepal. It was developed by J . L . Usiskin and widely used in America. I also need the student's score on mathematics from school's archival records. This study will provide valuable information regarding our student's 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 my any other purpose except the research. I will also provide you with a copy of the findings of this study.

I would be grateful to you if you allow me to administer the test and provide information.

Yours sincerely

Sanjit Kumar Ray

Appendix B

English Version of VHGT

Answer Sheet

Van Hile Geometric test (VHGT)

1. Do not start unit you are told to do so.

2. Write you are waiting, please fill the appropriate information in the spaces below.

Name:

School's Name:

Class:

Age (in year) ----- Sex, Boy [ ] Girl [ ]

3. This is an objective test, consisting of 20 multiple-choice questions; each question is followed by four options letters A to D. There is only one correct answer to each question. Read each question carefully and tick (√) the correct answer on this answer sheet. Do not make your answers on the test booklet.

1	A	B	C	D	11	A	B	C	D
2	A	B	C	D	12	A	B	C	D
3	A	B	C	D	13	A	B	C	D
4	A	B	C	D	14	A	B	C	D
5	A	B	C	D	15	A	B	C	D
6	A	B	C	D	16	A	B	C	D
7	A	B	C	D	17	A	B	C	D
8	A	B	C	D	18	A	B	C	D
9	A	B	C	D	19	A	B	C	D

10 A B C D 20 A B C D

English Version of VHGT

Time: 30 Minutes

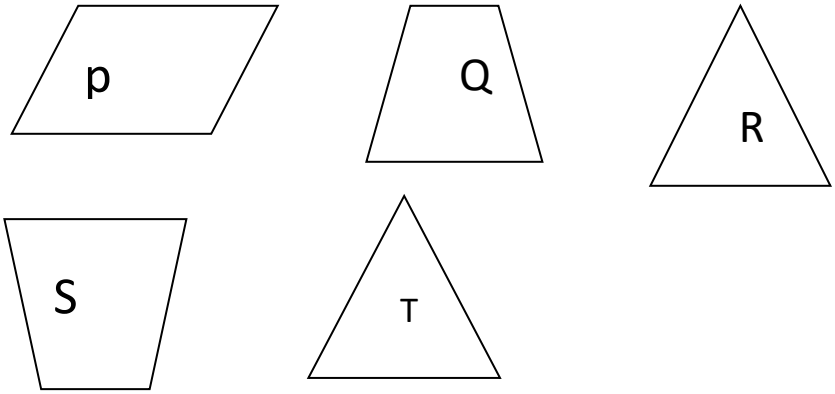
1. Which of the figures given alongside are triangles?

A. P and Q only

B. R only

C. S and T only

D. R and T only



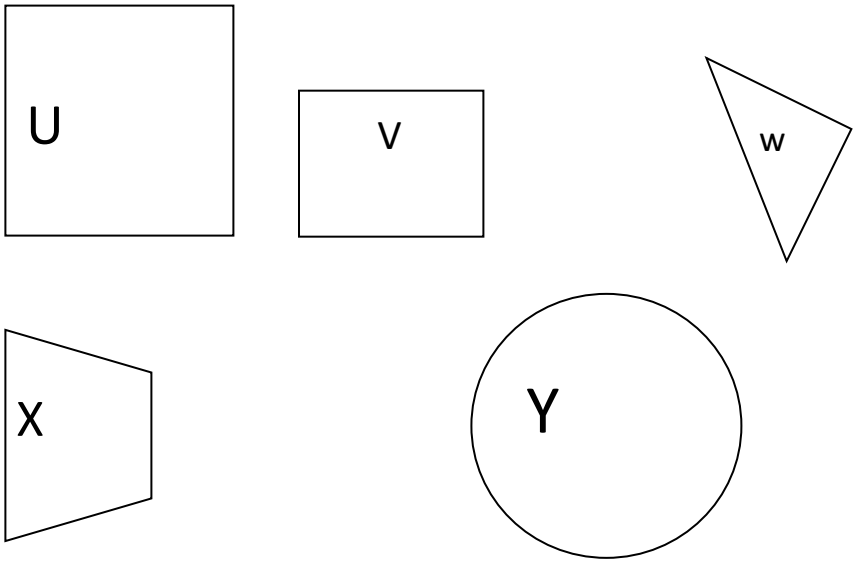
2. Which of the figures given alongside are rectangles?

A. U and W both

B. X and y only

C. Only V

D. None of these



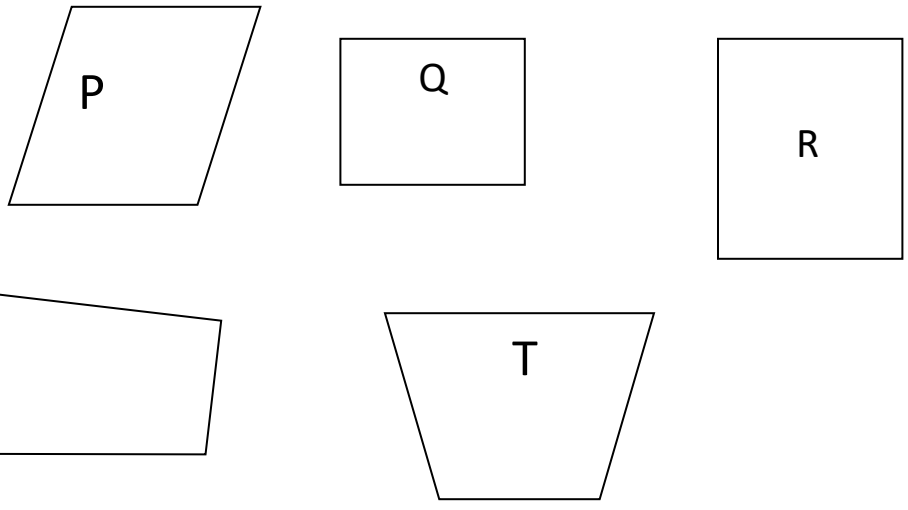
3. Which of the figures given alongside are quadrilaterals?

A. Both P and Q

B. Both S and T

C. Only R

D. All of these



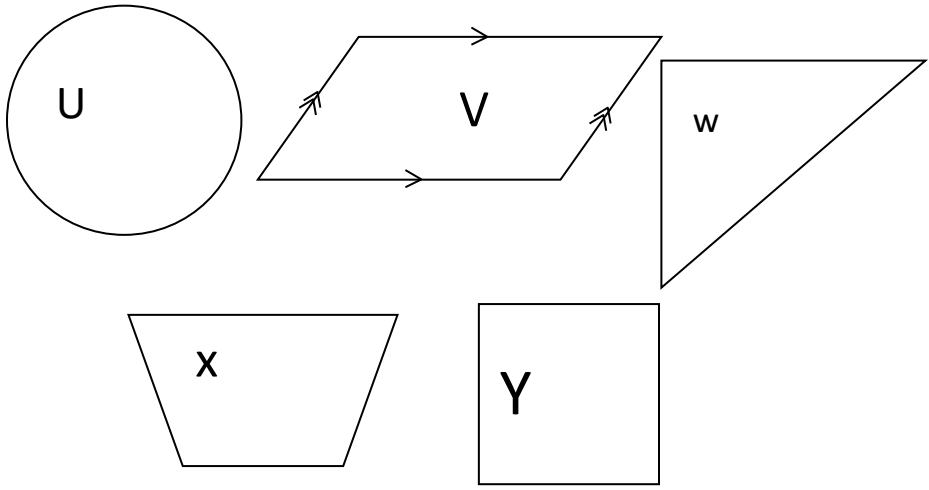
4. Which of figure given alongside is parallelogram?

A. Only V

B. Both V and X

C. Only U

D. Both W and Y



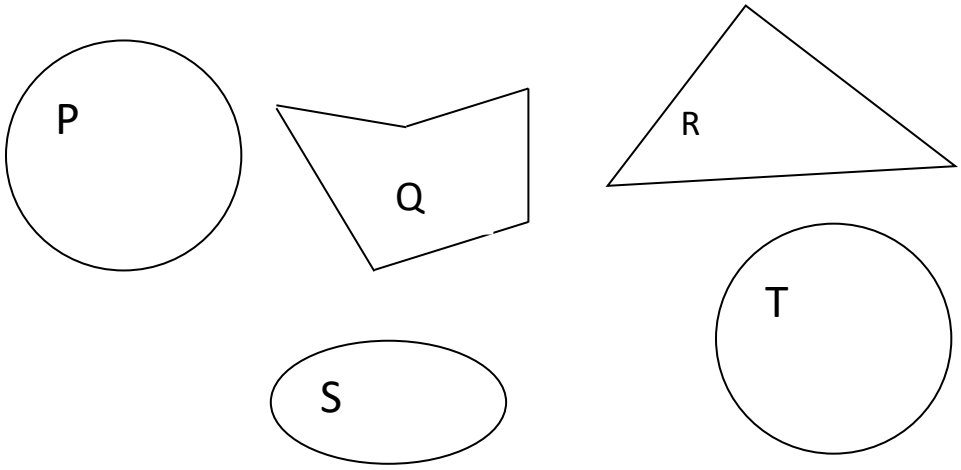
5. Which of the figures given alongside are circle?

A. Only P

B. Both Q and R

C. P, Q and R

D. Both P and T



6. Which of the following statements represents characteristics of a square?

A. All the sides of squares are equal.

B. All the angles of squares are right angle.

C. Opposite sides of squares are parallel

D. All of the above.

7. The measure of each angle of a rectangle is

A. $90^0/90^0$ B. $80^0/80^0$

C. $60^0/60^0$ D. $100^0/100^0$

8. Which of the following statements represents the characteristics of parallelogram?

A. Opposite sides are equal C. Opposite angles are equal

B. Opposite sides are parallel D. Both A and B.

9. The Sum of an interior angle of a quadrilateral is equal to.

A. 90^0 B. 180^0

C. 270^0 D. 360^0

10. The circumference angle of a circle subtends on same the same are

A. Not equal to each other

B. Equal to each other

C. Sometimes equal

D. All of the above.

11. A two dimensional geometrical figures which are enclosed by four sides are called.

A. Triangle B. circle

C. Quadrilateral D. pentagon.

12. If all the sides of triangle are equal to each other then the triangle is known as.

A. Equilateral triangle B. Isosceles triangle

C. Scalene Triangle D. Tangent

13. The Longest chord of a circle is called.

A. Diameter B. secant

C. Radius D. Tangent.

14. The portions enclosed by two radius and an arc between that radius are called.

A, Chord B. Sector

C. Diameter D. Circle

15. The Opposite sides of a parallelogram are.

A. Equal but not parallel B. Parallel but not equal.

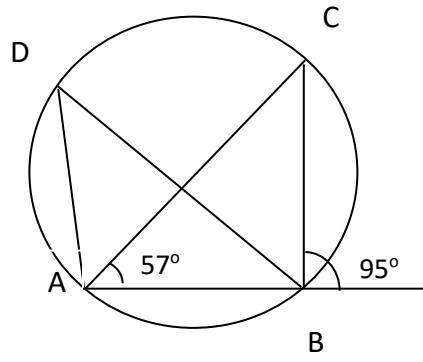
C. Equal and Parallel D. only equal.

16. In the figure given alongside.

If m∠BAC=57^0 and M∠CBE=95^0 then m∠ADB=?

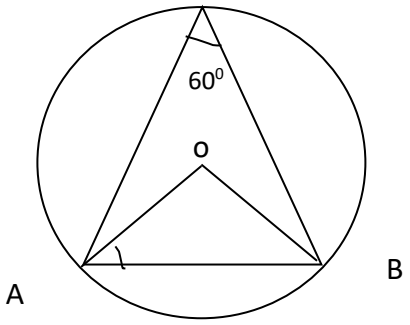
A.42^0 B. 38^0

C. 85^0 D. 35^0



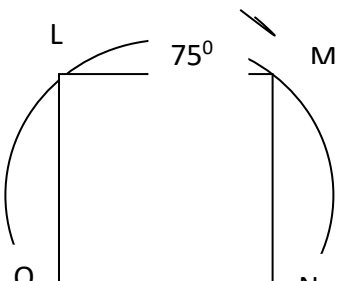
17. In the figure given alongside. O is the centre of the circle. If m ∠APB=60^0 then m∠OAB=?

A.30^0 B. 40^0 C. 50^0 D. 60^0



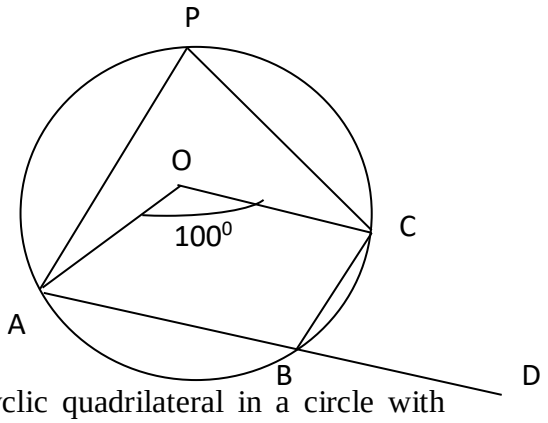
18. In the figure given alongside, m∠LMN=75^0 then what will be the m∠LON=?

A. 110^0 B.100^0 C. 105^0 D. 85^0



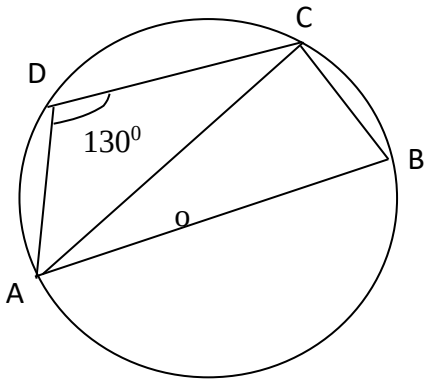
19. In the figure given alongside, m∠AOC =100^0, then what will be m∠CBD=?

A. 90^0 B. 400^0 C. 50^0 D. 450^0



20. In the figure given alongside, ABCD is a cyclic quadrilateral in a circle with centre O, in m∠ADC=130^0 then.

A. 50^0 B. 40^0 C.90^0 C. 45^0



Appendix C

Nepali Version of VHGT

Answer sheet

Van Hiele geometric test (VHGT)

lgb]{zgx?

!= of] k|Zgkq vf]Ng geg'~h]n vf]Ng' x'b}g,

@= s[kof vfnL 7fpFdf pko'Qm ;'rgf eg'{xf];\ .

ljBfnosf] gfd M–

ljBfyL{sf] gfd M–

sIff M–

pd]/ -jif{df_ lnË s]6f s]6L

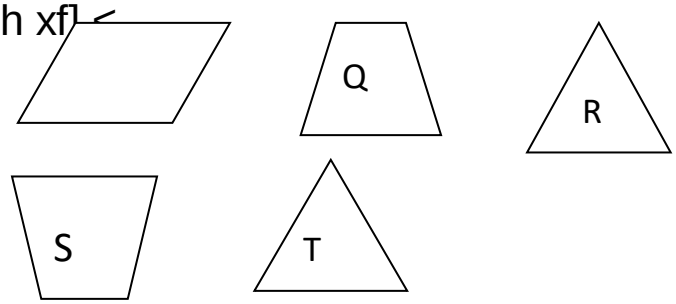
of] a:t'ut k|Zgkq xf], h;df @) cf]6f ax'j}slNks k|Zgx? 5g\ .

k|To]s k|Zgx?sf] rf/ – rf/ cf]6f ljsNkx? lbOPsf] 5 . h; dWo] Pp6f ;xL ljsNk 5 . k|To]s k|Zgx? Wofg k'j{s k9]/ o; pQ/ k'l:tsfdf /x]sf ;DalGwt k|Zgx?sf] ;xL ljsNkdf -√_ lrGx nufpg'xf];\ t/ k|Zg kqdf lrgf] gnfpg'xf]nf .

1	A	B	C	D	11	A	B	C	D
2	A	B	C	D	12	A	B	C	D
3	A	B	C	D	13	A	B	C	D
4	A	B	C	D	14	A	B	C	D
5	A	B	C	D	15	A	B	C	D
6	A	B	C	D	16	A	B	C	D
7	A	B	C	D	17	A	B	C	D

8	A	B	C	D		18	A	B	C	D
9	A	B	C	D		19	A	B	C	D
10	A	B	C	D		20	A	B	C	D

1. lbOPsf lrqdWo] s'g – s'g lqe'h xf] <



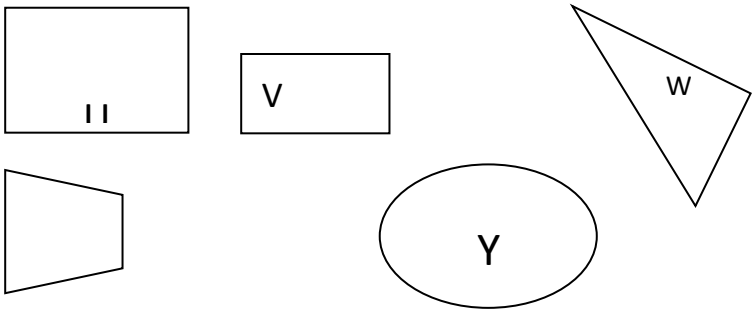
A.P / Q b'a}

B. R dfq

C. S / T dfq

D. R / T dfq

2. lbOPsf lrqdWo] s'g s'g cfot xf] <



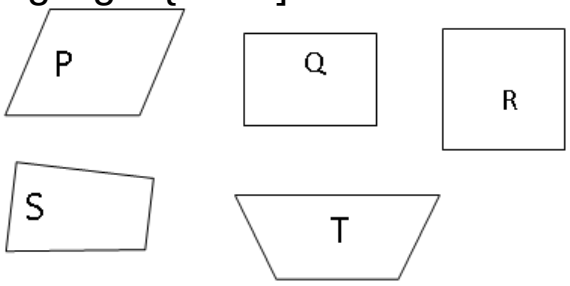
A.U / Vb'a}

B. X / Y dfq

C. V dfq

D.s'g} klg xf]Og

3. lbPsf lrqx? dWo] s'g s'g rt'{e'h xf] <



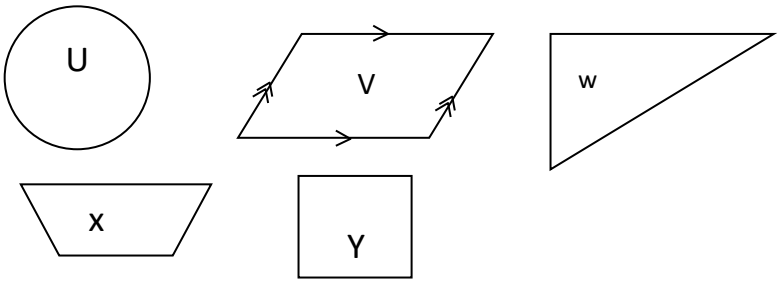
A. P / Q b'a}

B. S / T b'a}

C. R dfq

D. dflysf] ;a}

4. lbOPsf lrqx?dWo] s'g – s'g ;dfgfGt/ rt'{e'h xf]<



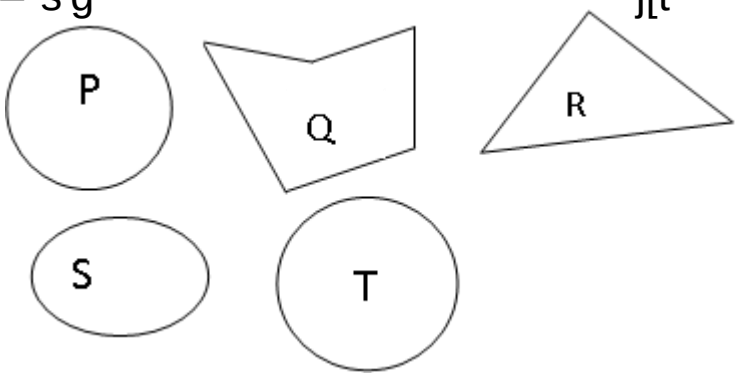
A. V dfq

B. V / X b'a}

C. V dfq

D. W / Y b'a}

5. lbOPsf lrqx?dWo] s'g – s'g j[t xf] <



A. P dfq

B. Q / R b'a}

C. P, Q / R

D. P / T b'a}

6. lbPOsf tYox?dWo] ju{sf u'0fsf u'0fx? s'g – s'g xf] <

A. ju{sf] ;a} e'hfx? a/fa/ x'G5 .

B. ju{sf k|To]s sf]0fx?sf] gfk 90/90 l8u|L x'G5 .

C. ju{sf ljk/Lt e'hfx? a/fa/ ;dfgfGt/ x'\G5 .

D. dflysf ;a}

7. cfotsf k|To]s sf]0fx?sf] gfk slt ÷ slt l8u|L x'G5 <

A. 90^0 B. 180^0 C. 270^0 D. 360^0

10. Pp6} rfkdf cwf/Lt kl/lBsf]0fx? M–

A. cfk;df a/fa/ x'b}g

B. cfk;df a/fa/ x'G5 .

C. slxnsfxL dfq a/fa/ x'G5 .

D.dflysf ;a} .

11. rf/ j6f e'hfx? ldn]/ ag]sf] aGb cfs[ltnfO{ s] elgG5 .

A.lqe'h B. j[Q C. rt'{e'h D. k~re'h

12. k|To]s e'hfx?sf] gfk a/fa/ ePsf lqe'hnfO{ s'g lsl;dsf] lqe'h x'G5 .

A. ;dafx' lqe'h B. ;dl4afx' lqe'h

C. ljifdafx' lqe'h D. dflysf ;a}

13. j[Qsf] ;a}eGbf nfdf] lhjfnfO{ s] elgG5 <

A. Jof; B.Secant ;]s]G6

C. cw{Jof; D. :kZf{/]vf

14. b'O{ cf]6f cw{Jof; larfs] efunfO{ s] elgG5 .

A. lhjf B. lf]qs

C. Jof; D. j[Q

15. ;dfgfGt/ rt'{e'hsf ljk/Lt e'hfx? cfk;df M–

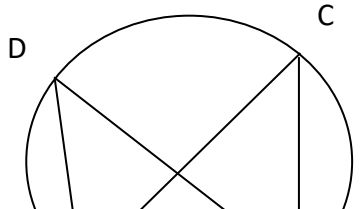
A. a/fa/ t/ ;dfgfGt/ x'b{g .

B. ;dfgfGt/ t/ a/fa/ x'b}g .

C. a/fa/ / ;dfgfGt/ x'G5 .

D. a/fa/ dfq x'G5 .

16. olb lbOPsf] lrqdf, $m\angle BAC = 57^0$/ $m\angle CBE = 60^0$eP $m\angle OAB$ slt x'G5 .



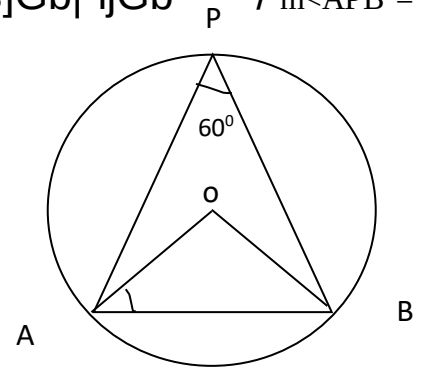
A. 42^0

B. 38^0

C. 85^0

D. 35^0

17. lbOPsf] lrqdf O j[Qsf] s]Gb| ljGb' ¸ / m<APB = 60^0 eP m <OAB slt x'G5 .



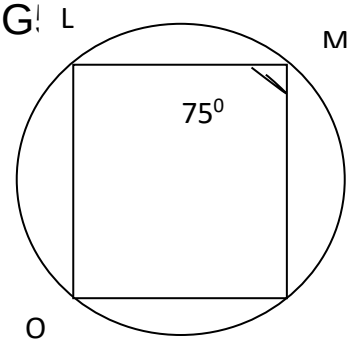
A. 30^0

B. 40^0

C. 50^0

D. 60

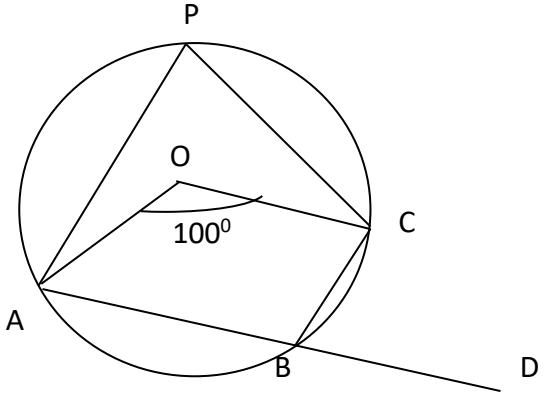
18. olb lbOPsf] lrqdf m<LMN = 750^0 eP m <LON sf] dfg slt x'G5



A. 110^0 B. 100^0

C. 105^0 D. 85^0

19. olb lbOPsf] lrqdf m<AOC = 100^0eP m <CBD sf] dfg slt x'G5 <



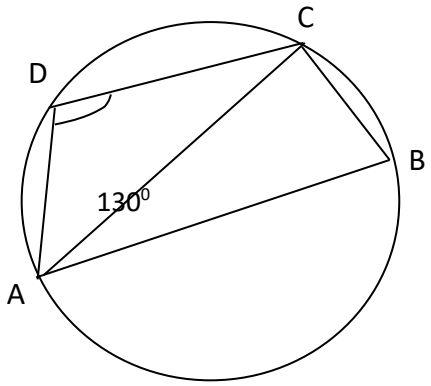
A. 90^0

B. 40^0

C. 50^0

D. 45^0

20. lbOPsf] lrqdf O j[Qsf] s]Gb| ljGb' xf], h;df m<ADC = $130^0$5g\ eg] m<BAC sf] dfg slt x'G5 <



A. 50^0

B. 40^0

C. 90^0

D. 45^0

Answer Sheet

1	2	3	4	5	6	7
D	C	D	A	D	D	A
8	9	10	11	12	13	14
D	D	B	C	A	A	B
15	16	17	18	19	20	
C	B	A	D	C	B	

Appendix-D

x	y	x=x-10	y-10	xy	x^2	y^2
50	35	40	25	1000	1600	625
55	40	45	30	1350	2025	900
40	32	30	22	660	900	484
55	45	45	35	1575	2025	1225
35	27	25	17	425	625	289
40	35	30	25	750	900	625
45	45	35	35	1225	1225	1225
40	45	30	35	1050	900	1225
40	38	30	28	840	900	784
20	18	10	8	80	100	64
60	63	50	53	2650	2500	2809

25	23	15	13	195	225	169
40	47	30	37	1110	900	1369
50	54	40	44	1760	1600	1936
35	40	25	30	750	625	900
20	21	10	11	110	100	121
20	25	10	15	150	100	225
15	12	5	2	10	25	4
30	25	20	15	300	400	225
35	40	25	30	750	625	900
40	36	30	26	780	900	676
30	30	20	20	400	400	400
45	38	35	28	980	1225	784
40	32	30	22	660	900	484
15	20	5	10	50	25	10
40	32	30	22	660	900	484
20	25	10	15	150	100	225
45	42	35	32	1120	1225	1024
50	48	40	30	1200	1600	900
35	30	25	15	375	625	225

Appendix-D

Calculation of correlation coefficient.

Here, N=30 $\sum x$=810

$\sum y$ = 780

$\sum xy$ = 23115

$\sum x^2 = 26200$

$$\sum y^2 = 21316$$

Where, x= x-10

y = y-10

Here,

$r_{xy} = r_{xy}$

Since the correlation coefficient is independent of change of origin,

$$r_{xy} = \frac{N\sum xy - \sum x \,.\, \sum y}{\sqrt{N\sum x^2 - (\sum x)^2} \,.\, \sqrt{N\sum y^2 - (\sum y)^2}}$$

$$= \frac{30\times 23115 - 810\times 730}{\sqrt{30\times 26200 - (810)^2} \,.\sqrt{30\times 21316 - (730)^2}}$$

$$= \frac{693{,}450 - 591300}{\sqrt{786000 - 656100}\times\sqrt{639480 - 532900}}$$

$$= \frac{107,650}{\sqrt{129900} \times \sqrt{106,580}}$$

$$= \frac{102,150}{360.42 \times 326.47}$$

$$= \frac{102150}{117666.32}$$

$$=0.872$$

$R_{xy} = 0.87$

Test of significance.

$$\text{Probable error (P.E.)} = 0.6745.\frac{1-r^2}{\sqrt{N}}$$

$$=0.6745.\frac{1-(0.87)^2}{\sqrt{30}}$$

$$= 0.6745\frac{1-07569}{5.477}$$

$$= \frac{0.6745 \times 0.2431}{5.477}$$

$$= \frac{0.16397095}{5.477}$$

P.E. (r) = 0.023

Appendix-E

Interview Schedule for teacher.

1. School's Name :
2. Teacher's Name :
3. Gender :
4. Teaching Qualification :

1. How Long Have You Be Teaching Mathematics?
2. Have You Had Any Training In Teaching Geometry?

3. Do You Familiar with Van Hiele Model Of GeometryThinking?
4. What Kind Of Problems Do You Encounter During Teaching Geometry?
5. Do You Think That Students Studying Of Secondary Level Come From The Lower Classes With Rich Experience In Geometry?
6. What Different Things Did You Notice On This VHGT In Comparison To Usual Test Of Your School?

Appendix-F

List Of School Selected For Study.

1. Shree Saraswati Secondary School Hajriya Barahathwa-3 Sarlahi.
2. Shree Baudhi Devi Secondary School Musaili, Malangwa-7 Sarlahi.
3. Shree Janta Secondary School Agarwa, Kabilasi-8 Sarlahi.
4. Shree Deodhari Secondary School Sundarpur Bazar, Kaudena-1 Sukhchaina Sarlahi.
5. Shree Ram Janaki Secondary School Chakkarghata-9 Khoriya, Sarlahi.