Chapter- I

INTRODUCTION

Background of the Study

Mathematics can be introduced in different ways. It is the logical study of shape, arrangement, quantity and many other related concepts. Technically speaking, it is the postulational science in which necessary conclusion are drawn from already specified premises (James and James, 1988). Mathematics is a vast adventure in ideas, an exact science and truly saying the mirror of civilization (Jha et.el; 2006).. It is clear that each and every activity of human is directly or indirectly related to mathematics. Mathematics is the building block for everything in our daily lives including mobile devices, architectures (ancient and modern), astronomy, art, banking, engineering and even sports. Also mathematics is being used in the field of science and technology and even in the widely different areas. So mathematics has a pervasive influence on our everyday lives and contributes to the wealth of society.

According to Perry, mathematics education began because it was useful, it continues because of the usefulness of its results.(As sited in Kathmandu University journal of science, engineering and technology vol.ii, no.1, February, 2006). Even the latest science and technological developments have extended each branch of mathematics and have proved mathematics as a powerful tool for any scientific achievements. (Jha et.el; 2006).

Seeing its importance, mathematics is given place in school curriculum as one of the compulsory subject. But it is disgusting to note that most of the students are being

unable to achieve the expected level of learning outcomes. It has been common to say that students memorize mathematical concepts, rather than understanding. Many studies also reported that the students didn't get sufficient exposure to learn mathematics in meaningful way. Such situation may have resulted poor performance of students in School Leaving Certificate examinations. Students' marks in SLC in mathematics have been consistently poor as shown by the following results.

Table 1.1

Average marks of regular students in compulsory mathematics

Year(in BS)	Appeared	Passed (in %)	Average marks in obtained out of 100
2067	427051	60.86	42.82
2068	496243	46.45	38.16
2069	528257	46.89	37.89
2070	547165	41.57	36.40
2071	566085	43.92	39.94

Source: statics of SLC result 2067-2071, OCE Sanothimi Bhaktapur.

The marks in the table presented above shows that the achievement of students in mathematics is not satisfactory at school level. Student's performance in mathematics is found to be comparatively poor. From the data of SLC result, many of students were failed in the subject mathematics. It is reported that most students who failed the SLC fail

in mathematics. So, mathematics is one of the subjects that cause mass failure in SLC examinations.

There are many factors associated with the poor performance of students in mathematics as mentioned by different studies. Among them, geometry in school mathematics has also been a areas for the poor performance in school mathematics (Fuys et. al, 1988). It is very notable that the subject "Geometry" though being visual and applicable to many physical situations, it has not been meaningful and interesting to many students.

Geometry is a branch of mathematics concerned with point, straight line, plane, plane figures, space, spatial figures and relation between them besides the measure of geometric figures including length, angle, area, volume, etc.(Baykul,1999). It is a branch of mathematics that provides a rich source of visualization for understanding arithmetical, algebraic, and statistical concepts (Drickey, 2001). Geometry is ultimately related to daily life activities of human beings. In each and every activities of mankind, directly and indirectly the geometry has been involved. National Council of Teachers of Mathematics in USA (NCTM, 2000) published a book where they set the principles and standard of the school mathematics. The book published by NCTM, (2000) highlights the importance of geometry and stress that geometry involves the reasoning and providing skills to students.

Although geometric concept has the visual aspect, students consider them difficult (NCTM, 1989). Despite the relative importance of mathematics, it is very disappointing to note that the student's performance in subject in both internal and external examinations remained poor (Salau, 1995). The mass failure in mathematics is a real and the trend of students' performance has been on the decline (Adolphus, 2011). There are

many studies showing that students have many difficulties in understanding in geometry, which is a crucial component of mathematics education (Mayberry, 1983; van Hiele-Geldof 1984; Mitchelmore, 1997; Thirumurthy, 2003). According to Meberry(1983), students mostly learn geometric concepts based on a rote learning approach. Clements and Batista (1992) indicate the reasons for student's misconceptions about geometric concepts as follows: "Students do not understand the subject sufficiently, they organize specific rules about geometric expressions, they mostly learn by rote and they cannot understand the concepts exactly."

According to latest curriculum of Nepal, 24% course weightage of mathematics is being covered by geometry at school level. The school mathematics curriculum of Nepal shows that at secondary level, geometry course is basically proof oriented and at the lower secondary level geometry is presented informally. The informal geometry at lower secondary level is mainly aimed at developing properties of geometric objects through observation, measurements, classification, verification, description etc. one of the objective of geometry of lower secondary level is to lay foundation for secondary school geometry. Such objectives couldn't be fulfilled if the geometry course of lower secondary level is developed and taught appropriately. In such circumstances the researcher became motivated to study reasons behind poor performance of students (lower secondary level students) in geometry.

In context of Nepal, what is commonly perceived is that both understanding and achievement is poor in geometry. From the responses of many teachers and students, one of the reasons of failure in mathematics is geometry. According to mathematics teachers, students cannot understand geometric concepts appropriately. Most of the students either

skip or do wrong solution of questions in geometry in their examinations. And the students are unable to link necessary properties while proving theorems, solving problems etc. They also claimed that geometry contributed to the failure of many students in mathematics. Many attempts have been made to diagnose students' weakness and misconceptions in geometry. In this direction van Hieles model of thinking has been found effective (Fuys, et. al,1988; Clements and Battista 1992; Shrestha, 2005). This is why this study is aimed at exploring misconceptions of lower secondary school students' in geometry in order to provide lapses and misconceptions of students in geometry.

Misconceptions are the perceptions of concepts by students in different ways rather than their mathematically accepted definitions. Misconceptions may involve mistakes, or errors, or misleading ideas or misinterpretation of ideas or facts (Wikipedia). A misconception usually results from incorrect thinking or a flawed understanding. About the word misconception the online dictionary Vocabolary.com writes "a misconception is a conclusion that's wrong because it is based on faulty thinking or facts that are wrong". From the Encarta online dictionary, a misconception is "a mistaken idea or view resulting from a misunderstanding of something". Similarly Oxford Dictionary (2010) defines misconception as a view or opinion that is incorrect because of faulty thinking or understanding. So the student's conceptual misunderstandings which resulting from faulty thinking are misconceptions that are the obstacles for student's perception on subject matter.

Several studies have indicated that students have problem in comprehending geometric concepts, which is an important aspect of learning mathematics. According to Mayberry (1983) most students learn geometry based on rote-learning approach. The

student may hold the visualization and the verbal definition, but prefer the visual prototype when classifying and identifying geometric figures (Ozerem, 2012). Researchers have given reasons for students' misconceptions in geometry. The reasons given by Ozerem (2012) include students' reliance on the physical appearances of the figures, inability to associate geometric properties with one another, overgeneralization and rote learning. Clement and Battista (1992) enumerated some of the causes of students' misconceptions in geometric concepts such as (i) lack of understanding the subject sufficiently, (ii) overgeneralization of specific rules (iii) rote learning and (iv) inability to comprehend geometric concepts exactly. The reasons given by Ozeren (2012) and Clement and Battista (1992) are similar, as they are centered on lack of conceptual knowledge due to rote learning approach.

According to Mayberry (1983) and Clements and Battista (1992), geometric shapes presented in non-standard forms are hardly recognized by many students, as they perceive a square as not a square if it is not on a horizontal base. Many students have problems in perceiving class inclusions of shapes, for example, they do not think that a square is a rectangle, or a square is a rhombus, and a rectangle is a parallelogram (Mayberry, 1983; Feza & Webb, 2005; Marchis, 2008). Other common misconceptions include, using the bottom line as the base of the triangle in calculating the area of a triangle; larger space means larger angle; inability to understand the angles in parallel lines- alternate and corresponding angles; inability to recognize and perceive the properties of quadrilaterals and learning formulas and definitions inadequately. According to Biber, Tuna and Korkmaz (2013) students lack knowledge of parallel lines and they calculate angles based on the physical appearances of the figures. According to

the different research studies both the teachers and students at lower secondary level have the misconceptions in geometry. This is why lower secondary school students' misconceptions in geometry have been taken as the subject of study in this research.

Significance of the Study

Addressing misconceptions during teaching does actually improve the achievement and long term relation of mathematical skills and concepts (Askew and William 1995:13). Geometry is one of the main areas of mathematics at school level. It is the fundamental concept in mathematics playing central role as conceptual component. The identification of student's misconceptions in geometry might be done through multiple ways. For the student's better performance in the geometry, it is necessary to identify the mistakes and misconceptions regarding the prior concepts about it.

The main significance of the present study was to determine the misconceptions experienced by the lower secondary level students in geometry as well as the reasons for such misconceptions. After the identification of such misconceptions, it would be easier to the teachers to improve their teaching and to avoid misconceptions. Also this study would impact positively in student's achievement. Moreover the significance of the present study can be listed below:

- It would provide the appropriate information about pupil's mistake and misconceptions in geometry.
- It would be supportive to improve the instruction.
- The study would provide information on students' misconceptions in geometry on the basis of van Hiele model of thinking.

- It would more beneficial for further study about student's problems in geometry.
- It would be helpful to the teachers for their professional development.
- The significance of the study also lies on the usefulness of van Hiele levels in assessing misconceptions in geometry.

Statement of the Problem

The poor performance of students in mathematics and geometry has been a matter of concern to mathematics educators, parents and government. From the statistics about SLC examination, mathematics is found to be one of the major subject due to which the total SLC failure rate is increased. By analyzing every years SLC result, it is found that most of the students who failed in their SLC examination are failed in the subject of mathematics. The SLC result of last five years presented in table 1.1 shows that the performance of students in mathematics is not satisfactory.

In the context of Nepal, there is low achievement of many students in mathematics at school level. The result of different achievement tests such as different terminal examinations, District Level Examination (DLE), School Leaving Certificate (SLC) examinations etc. are the evident for this fact. Lower secondary level is the bed rock of the school level. This is very much important phase of learning. Students have to learn different basic concepts appropriately in this level. Geometry is one of the main portions of school mathematics which can play significant role in student's achievement in mathematics. Geometry is one of the core difficult areas where students' performance has always been low (Adolphus, 2011). Among many factors, one of the factors causing low achievement in mathematics could be the misconceptions of the students regarding the concepts of geometry. Such mistakes and misconceptions might have played

significant role on failure of students. On the other hand such situation might have embedded to the learning of more geometric concepts. For this reason the researcher is interested to explore lower secondary level students' misconceptions in geometry. So the present study is aimed at addressing the following questions.

- What are the misconceptions among the students of lower secondary level in geometry?
- What is the level of learning (van Hiele level) of lower secondary level students in geometry?

Objectives of the Study

The study was done to attain the following objectives.

- To explore the misconceptions of lower secondary school students in geometry.
- To classify misconceptions of students' into different levels of van Hiele model of thinking.

Delimitation of the Study

This study is limited on the following aspects:

- The study was limited to lower secondary level students in Chamunda resource center of Dailekh district.
- The sample of the study (sample school) was taken in accordance to the convenience of the researcher.
- The study was only limited to the mistakes and misconceptions of lower secondary level students in geometry.

Definition of Related Terms

Misconception: A wrong conclusion about geometric concepts based on faulty thinking or wrong conceiving of subject matter.

Mistake: Calculation fault made by students during problem solving.

Geometric problem: Questions/problems from geometry section of lower secondary level.

Achievement score: Score obtained by students on mathematics tests.

Students: All the lower secondary level students of Chamunda Resource Center of Dailekh district.

Performance: Student's ability in solving geometric problem.

VHGT : A test developed on the basis of van Hiele level of geometric thinking.

Chapter-II

LITERATURE REVIEW

A literature review is the survey of already existing writings on a given topic or area with a view to assessing their relevance to a proposed project. The review of related literature involves the systematic identification, location and analysis of documents related to research problems (Gay, 1987). Hart (1998) defined the literature review as "the use of ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new" (p. 1). The main purpose of reviewing the literature is to determine what has been done and what is needed to be done for the current study. In other words, it provides background and the context for the research problem (Wiersma, 1995). It helps research, research programs and gives the better idea in every steps of research. Also, the literature review is done to eliminate the duplication of the task.

The literature review has been divided into two parts: the review of theoretical literature and the review of empirical literature.

Review of Theoretical Literature

Since the study is based on identifying/exploring students' misconceptions according to van Hiele model of thinking, the van Hiele Model of geometric thinking has been reviewed under theoretical literature.

van Hiele Model of Geometric Thinking

Dutch educators P.M. van Hiele and his wife Dina van Hiele Geldof developed a new model of geometric thought of students' as theirs doctoral works. The model contains five levels which are as follows:

Level 0 (Basic Level): Visualization

At this level the geometric concepts are viewed as total entities rather than as having components or attributes. Students perceive a geometric shape by their physical appearance not by their parts and properties. At this level a learner can learn geometric vocabulary, identify specific shapes, and reproduce a figure according to given figure. But they cannot consider the properties on parts of shape. i. e. in a rectangle s/he would not recognize that figure has four right angles or the opposite sides are parallel.

Level 1: Analysis/ Descriptive

At this level the analysis of geometric concepts begins. Students at this level can perceive the characteristics of figures. Figures are recognized not only as a whole but also as parts. A student of this level can establish the relationship between parts of geometric shapes by measuring, tilling etc. Class inclusion is not understood at this level and students at this level cannot explain relation between properties (i.e. if opposite sides are equal in quadrilateral then ultimately they are parallel). Interrelation between figures is not seen and definitions are not yet understood.

Level 2: Informal Deduction/relational

In this level students can establish the interrelationship between properties with and among the figure. Class inclusion is understood. Informal arguments can be followed

and given. But the student at this level does not comprehend the significant of deduction as a whole or the role of axioms. Empirically obtained results are often used in conjunction with deduction techniques. Students at this level can follow the formal proof but do not see the how logical order could be altered.

Level 3: Deduction

At this level, students can understood the significance of deduction as way of establishing proofs within an axiomatic system. The interrelationship and role of undefined terms, axioms, postulates, definitions, theorems and proofs are seen. Distinction between a statement and its converse can be made.

Level 4: Mathematical Rigor

At this level a student can work in a variety of axiomatic system. Different systems (i.e. non-Euclidean geometry etc.) can be compared. Geometry is seen as abstract.

The main characteristics of the levels are:

1. The levels have a hierarchic arrangement through which the person moves sequentially.
2. Moving from one level to the next is more a result of a learning process rather than a result of age or maturation.
3. The inherent objects of one level become the object of the next level.
4. Each level has a unique language, set of symbols, and network of relations joining these symbols.

5. If the student is at one level and the instruction is at a different level, the desired learning progress may not occur.

According to the article entitled, "Misconceptions in Geometry," retrieved from http://geometry modules.Wikis, here are some common misconceptions that continue to prevail in school math classes when geometry is taught:

1. *Conservation misconceptions*

   Pupils often believe that that the rules of invariance that apply to algebra also apply to geometrical shapes.

2. *Student's classification of shapes*: Often times, students have very fixed mental images of what a particular shape should look like; these mental images are typically of images of shapes that are very basic.
   a. '…a rectangle is a long shape'…and… 'a square is not a rectangle…'
3. *Changing the orientation or view of a shape suddenly changes what type of shape it is***:** Students are taught specific criteria of what makes up a shape and not so much specific properties and relationships between shapes. So they may have misconceptions regarding:
   a. Identifying the base and height of triangles
   b. Shape properties
   c. Orientation and Rotation of Shapes
4. *Angles*: Larger space means larger angle
5. *Perpendicular lines*: students only perceive horizontal and vertical lines as perpendicular; not ones that intersect diagonally, but at 90 degrees.

6. *Lines of symmetry***:** students usually find more lines of symmetry than actually exist; cutting a shape in half implies that it creates the exact same image on both sides of the line
7. *Language***:** Due to language there might be difficulty with student to understand the concepts.
8. *Misconceptions regarding proofs in geometry*
    a. To identify what is given and what is to be proved.
    b. To associate properties with other knowledge required for proof

Review of Empirical Literature

Review of empirical literature includes the research studies related to the subject of study. Best and Kahn, 2009 suggests that a literature review should describe what is studied, how is it carried out and what was the findings. Some of the empirical studies related to this study have been reviewed below.

Fuys, Geddles and Tischler (1988) conducted clinical interviews with pre-service and in-service teachers which provided a basis to explore teachers' thinking in geometry based on van Hiele Model. The study indicated that only one pre-service and in-service mathematics teachers' (out of 13 teachers) were able to give a careful deductive argument for the relation "the area of triangle is half the area of rectangle". It is notable that some of the misconceptions were same as those of sixth and ninth graders.

Kuth (2002) conducted an exploratory study which examined 16 in-service secondary school mathematics teachers' conception of proof. Data were collected through interviews and task designed focusing on proof. The result of the study reported

that teachers could not recognize the variety of proof plays in mathematics and teachers held limited views on the nature of proof.

Bayram (2004) conducted a study on 106 eighth grade students in one of the private schools in Ankara on the effectiveness of the instruction with concrete materials on student's geometry achievement and attitudes towards geometry. The data gathered from eighth-grade heterogeneously grouped math classes using concrete materials with the experimental group, and using traditional teaching methods (no concrete materials) in the control group. Achievement was measured using a test (GAT) developed by the researcher, and attitude was measured using a Geometry Attitude Scale (GAS). In this study a pre-test given to both experimental and control groups showed that the control group had a statistically higher mean score on the Geometry Achievement Test (GAT) thus emphasizing research conducted by Dutch educators van Hiele and van Hiele-Geldof (1958) that students need help from concrete materials as they move through the levels of thinking required for understanding geometry.

Lamsal (2005) conducted a research entitled "The effectiveness of van Hiele approach in teaching geometry at lower secondary level." The objective of his research was to explore the effectiveness of van Hiele approach in teaching geometry. The research was experimental and *post test only equivalent group design*. The finding of this study shows that van Hiele approach in teaching was found to be more effective. This approach was found to reduce difference in boys and girls in terms of achievement.

Kaphle (2006) conducted a research entitled "error analysis of the proof of theorem in geometry in grade X". The objective of his study was to identify the student's errors based on Newman error analysis in the proof of theorem. The research was

conducted in qualitative design. The population of his study consists of all students of grade X students of Shree Nagarjun Thuladhunga Secondary School Jeetpurphedi, Kathmandu. The samples of 20 students were selected by purposive sampling method from the case school. The finding of the students was that one fourth of the errors that found in the proof of theorems in geometry were centered in reading and comprehension, where the highest error is found in the processing skill.

Atebe (2008) conducted a research entitled "Student's van Hiele level of geometric thinking and conception in geometry: A collective study of South Africa and Nigeria". His main objective was to explore and explicate the van Hiele level of geometric thinking of selected group of grade 10, 11 and 12 grade students in Nigerian and South African students. The interpretive research design was used with qualitative and quantitative methods. By using purposive and stratified sampling process 144 mathematics learners were selected from the population of the study. As a research tools the questionnaires, interviews and classroom videos were used. Data obtained were analyzed by using descriptive as well as inferential statistics. The findings of his study were i) 47%, 22%, 24%, 2% and 3% percentage were found in levels 0,1,2,3 and 4 respectively. ii) Learners form Nigerian subsample has proper knowledge in school geometry than that of South African sub sample.

Mateya (2008) conducted a research on "using van Hiele theory to analyze geometrical conceptualization in grade 12 students: A Namibian perspective". The purpose of his study was to give understanding of the application of the van Hiele levels of thought in exploring geometric conceptualization in grade 12 students. In the sample of 50 grade 12 students (20 from school A and 30 from school B) selected purposively

from the 12th grade students of Namibia, the tools for study were used VHGT and clinical interviews. Main findings of the study were 35%, 25%, 30%, 10% and no one from school A and 40%, 20%, 23.3%, 6.7% and one student from school B were found in levels of 0, 1, 2, 3, and 4 respectively.

Bhatta (2009) conducted a research entitled 'The error analysis on the problem-solving area of triangle and quadrilaterals' aiming to identify and analyze the errors committed by students in knowledge, skill, application and problem solving. Fifty students of grade X were selected as a sampling by random sampling method. The findings of his study were that the errors committed by the comprehension, transformation, process, encoding and reading skills found in descending order.

Ghimire (2010) conducted a research entitled by "A research on grade VII students in geometry at Lamjung district". The design of his study was quantitative. This study was intended to find the achievement level of students comparing by gender wise (male and female) and according to the type of school (public and private). Five private and public schools were selected randomly as a case school, from the population of all secondary schools of Lamjung district. Paper pencil test were conducted as a tool for data collection which contained achievement test questionnaire prepared by the researcher according to the objective of the study. The statistical tools mean, standard deviation, t-test at o.05 level of significance were used to analyze and interpret the data. As a result it is found that there is a significant difference between students studying private and public school. The achievement of private schools is found to be better than that of the public schools where as the achievement of boys was found better than that of girls.

Chand (2012) conducted a research entitled 'Analysis of error committed by the secondary level students in solving geometric problems', aiming to determine the pattern of errors committed by students in solving geometric problem and to find the pattern of errors of good performers and poor performers. Descriptive survey design was used with Neumann's procedure of error analysis together with van Hiele level of thought in geometry as theoretical basis. Two public schools (one from rural and one from urban area) and two private schools (one from rural and one from urban area) were taken from the total population all secondary schools of Kavre district. 200 students were selected purposively and a written test was administrated to them. Also a mini sample of 20 students was selected purposively from the sample for interview. As a result it found that two third of the total students made either comprehension or transformation errors. The comprehension errors were mad because of lack of proper understanding of geometric terminologies and less skills to draw geometric figures representing problems/theorems. The transformation error was made because of insufficient knowledge of definition and theorems and less likely to apply them in unfamiliar situations.

Cigri Biber and et al (2013) conducted a research entitled "The mistakes and misconceptions of eighth grade students on the subject angles". The purpose of this study was to determine the learning levels, mistakes, and misconceptions of the 8^{th} grade students on the subject of "angles in geometry" as well as the possible reasons for these situations. Research sample consisted of 30 students attending the 8th grade of a middle school located in the central district of a northern province of Turkey during the 2012/ 2013 academic year. An achievement test containing 4 open-ended questions were used as a data collection tools in this study. Firstly, the answers given were divided into two

parts: correct and incorrect. Then, incorrect answers were split into sub-categories and tabulated. According to the results of the study, (1) students paid attention to the physical appearances of geometric figures alone without taking into consideration their geometric properties; (2) although they detected some geometric properties of figures, they failed to associate these properties with other knowledge required for solution; (3) they generalized a property that was valid for only a specific condition over different situations; (4) and they did not fully comprehend the concept of parallelism on the subject of angles.

Thapa Magar (2013) conducted an action research entitled “Careless Errors Made by Grade VII Students” aiming to identify the careless errors done by grade VII students. Vanu Memorial Secondary Boarding School Chitwan, was sampled for the study where the careless errors done by students of grade VII, were investigated. He identified 13 type of errors altogether which were: Not reading directions, not following directions, incorrect computation, incorrect level, not showing all steps, wrong answer in blank, , no level, no name on paper, carrying down wrong answer, skipped problem, no answer in blank, other. The researcher also identified that among all the errors, first four were more prominent.

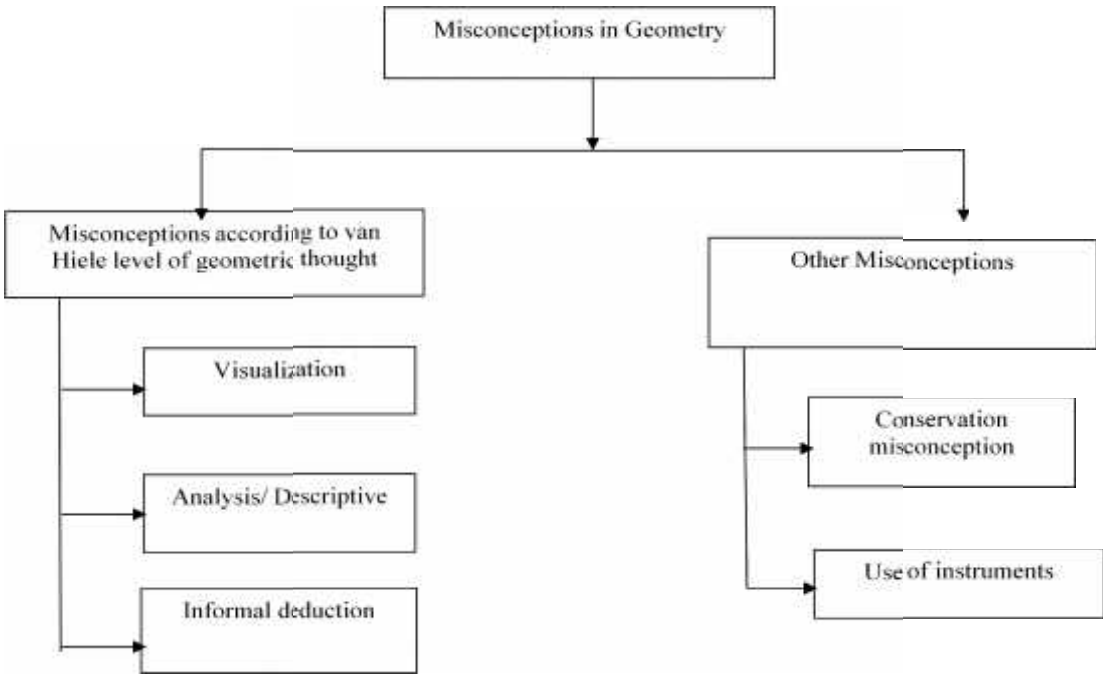
Nepali (2014) conducted a research entitled “A Study on errors committed by grade VII Students in Geometry Learning”, aiming to study patterns of errors committed by the VII students while solving construction problems in geometry. The study was an intuitionist research added with interpretive design. The sample of the students contained of 30 students of Shree Bisanudevi Secondary School of Kathmandu district. The test consisting eight questions according to grade VII mathematics course was administrated

as a tool for data collection. The answer sheet was analyzed on the basis of Neumann technique of analyzing error. The error of each type were tabulated separately and converted in to percentage to make comparison easy. The study revealed that the students have committed number of errors on solving construction problems on geometry. Students committed more error on comprehension level and transformation level. He also claimed that the language problem is one of the causes of high percentage in these errors.

Present research was conducted in order to identify the misconceptions experienced by lower secondary level students in geometry. The van Hiele approach of geometric learning was used as a main theoretical basis of this study

Conceptual Framework of the Study

From the above review of related literatures the following misconceptions of students have been found to be included in the study.



The misconceptions were assessed through written test and interviews of students.

Chapter-III

METHODS AND PROCEDURES

This chapter deals about the design of the study. This part deals about the population and sample of the study, tools for data collection, reliability and validity of the tools, data collection, data analysis and interpretation procedure. The main purpose of the study is to find out the misconceptions in geometry that experienced by students at lower secondary level. In order to achieve the purpose, the study was carried out in the following way.

Design of the Study

A research design is a systematic plan to study a problem. It is an arrangement of different component of study, which defines the study type. This study was intended to identify the student's misconceptions in geometry at lower secondary level. So the descriptive survey design including test related to misconceptions in geometry (VHGT) was supplemented by semi-structured interviews.

Population of the Study

The study was conducted at Chamunda resource center of Dailekh district, which is one of the hilly districts of mid-western development region of Nepal. This Resource Center is situated at the western part of Dailekh district, which is one of the remote area. This resource center consists of 72 government schools and 42 Child Development Centers covering four VDC's Chamunda, Kusapani, Jambukandh and Layanti Bindrasaini of Dailekh district. The population of the study consists of all the students of lower secondary level in Chamunda resource center. There are 15 lower secondary, eight

secondary and four higher secondary schools in this area. The student enrolled in lower secondary level in the academic year 2015-2016 was about 3000 which was the population for the present study.

Sample of the Study

A sample is small representative portion of population that is selected for observation and analysis (Best and Kahn, 2009). For this study, eight public schools viz. Chamunda Higher Secondary School, Chamunda; Jayadev HS School, Jambukandh; Kalika Secondary School, Netrapani; Janata Secondary School, Bastekot; Bhairab LS School, Basthana; Bindrasaini Secondary School, Layatibindrasaini; Jayasewa LS School, Lekdanda; Janata Secondary School, Lainchaur of the Chamunda resource center were selected purposively to from different area of the resource center. All the Lower Secondary level students (VIII grade) of sample school were taken as sample for the study. There were 215 students in the sample.

A test based on misconceptions in geometry was administrated among the sampled students. According to the result of test, a sub sample of 20 students was selected randomly out of 178 who were fitted to the success criterion for van Hiele level. Among the sub sample of 20 students, ten students were selected randomly from visual level, six students from analytic/descriptive level and rest four students from informal deduction level.

Construction and Validation of Tools

One of the most important parts of the study is data collection. Normally whatever the problem contained in a data collection tools are fit for mesurement purpose

and present the domain which is intended to be measured is determined on ‘expert openion’ (Karsar, 1995). For this study the following tools was constructed and validated.

Construction of Test based on Misconceptions in Geometry

Since van Hiele approach of geometric thought is taken as main theoretical basic for the research, a student’s van Hiele level of Geometric thinking was assessed by his/her performance on van Hiele Geometry Test connsisting of 20 multiple choice items with five alternatives on each. Since the geometry of lower secondary level is limited to first three van Hiele levels, the test was limited to first three van Hiele levels. The test contained three sub tests on first three van Hiele levels: Visual level(8 items), Descriptive/Analytic level (8-items) and Informal Deduction level(4-items). The items were piloted to 25 eighth grade students of Shree Janakalyan Lower Secondary School, Budeli, Dailekh. The test is placed in Appendix A with instructionns about how to response the test items.

The success criterion and scoring criterion for the van Hiele Geometry test is different from other test. A student was assigned a van Hiele level if the following conditions were satisfied: if the student answered correctly 5 items out of 8 and 3 out of 4 items in a given sub tests; and if a student fulfilled this criterion at consecutive levels. Such success criterion has been adopted by van Hiele researchers (Usiskin and Senk, 1982) based on van Hieles assumption that a student cannot achieve heigher level of thinking without passing through preeceding levels. A student who could not meet the success criterion was not assigned a van Hiele and such students were excluded from the final sample used in the study.

Validity of Test

A test is said to be valid if it measures what is intended to measure. The validity of the test was established by constructing the questions based on content points and van Hiele levels descriptors. After piloting and consulting with the experts, the test was finalized.

Reliability of Test

Reliability of test refers the consistency measured by a test. Reliable tests are stable in whatever they measure and yield comparable scores on repeated administration of test (Best and Kahn, 2010). To evaluate reliability of test it was piloted to 25 lower secondary level students of Dailekh district and the piloted school was not included in the sample. Coefficient of reliability was calculated through Spearman's split half method and it was found 0.91. The correlation coefficient showed that the test was reliable.

Interview (semi structured)

The main purpose of the study is to identify the student's misconceptions and their level of geometric thought. For this purpose, the VHGT only was not sufficient. Thinking level of students was not possible to identify the test, so it was supplemented by a semi structured interview. A semi structured interview schedule was developed in order to identify the misconceptions of students regarding geometry. For the interview, questions were developed by researcher based on van Hiele level descriptors mentioned under the review of theoretical literature. The interview schedule included questions targeted to explore students misconceptions mainly based on van Hiele levels. The

interview schedule was mainly targeted to assess misconceptions through semi-structured interviews.

Reliability and Validity of Interview

To evaluate reliability of interview, it was piloted by conducting repeatedly to some selected students of the small group to whom the VHGT test was piloted. The validity of interview was finally ensured by judgment of supervisor. Consultations with other researchers were also made for the validity of the interview schedule.

Data collection Procedures

To collect the data, the resercher visited the sample schools and concerned personals for co-operation and help. After visiting the sampled schools, schedule for the tests was held. The van Hiele Geometry Test (20 items multiple choice test) prepared by the researcher was administreted as a paper pencil test to the sample. The test was administrated in the sampled students of the sampled schools from 18th and 19th November 2015AD following the uniform condition of administration. The test was targeted to examine the misconceptions in geometry of lower secondary level students in the line of van Hiele Level of Geometric thinking. The test was first administrated to 215 students of lower secondary level (VII grade students) of all the sampled schools.

After administrating the test and scoring the test, a sub sample of 20 students was selected purposively for the interview so as to include students from different van Hiele levels. Semi structured interview was conducted to collect descriptive and qualitative informations on possible misconception in geometry. At the time of interview language used in the responses were evaluated, and some important responses were noted.

Data Analysis Procedure

Descriptive statistical techniques (percentage/ frequency) were used for analyzing the data acquired from the van Hiele test. The data was also analyzed in terms of types of misconceptions in the line of van Heile level of geometric thinking (That is the misconceptions evidenced by students in answer sheets was categorized level wise according to van Hiele level of geometric thought). The analysis was focused mainly on students' misconceptions in the line of van Hiele model of thinking.

Data collected from interview was classified into different level (van Hiele levels) as well as the type of misconceptions. Exploratory methods of analyzing the data were used for the information on the test. Simple percentage was used in the interpretation of the data obtained from the test.

Chapter-IV

ANALYSIS AND INTERPRETATION OF DATA

This chapter deals with the analysis and interpretation of the data obtained from the tests. A level based test on geometry called van Hiele Geometry Test (VHGT) was administrated to entire sample of lower secondary school students while a semi structured interview was conducted to a sub-sample of 20 students drawn from 215 students who had taken the van Hiele Geometry Test. In this study the data were collected from answer sheet of VHGT and responses given in the interview. So the analysis was made on the following headings:

- Analysis of data obtained from van Hiele Geometry Test
- Analysis of data obtained from interview.

Analysis of Data Obtained from van Hiele Geometry Test

The van Hiele Geometry Test (multiple choice test) consisting of 20 items on first three levels (visual, descriptive/analytic and informal deduction) was administrated among the sampled students. The answer sheets were scored and students were assigned van Hiele levels according to success criterion (5 of 8 or 3 of 4 success criterion). To be at some level, a student should meet success criterion of that level and success criterion of all preceding levels. Students not fitting in such scheme are said to be unfit. Assigning van Hiele levels in such a way, the following results were obtained.

The test was administrated among 215 lower secondary level students (VII grade students), among which 178 students were found to be fitted and 37 were unfit in level scheme. The distribution of students into van Hiele levels has been given in table 3.1.

Table 3.1: Number and percentage of lower secondary level students at each van Hiele level

Level	No. of students	Percentage (out of fit)
Visual level (level 0)	109	61.2
Descriptive/ Analytic (level 1)	51	28.7
Informal deduction (level 2)	18	10.1
Total fit:	178	100%

The table shows that out of 215 students, who took part in the test, 178 fitted at different van Hiele levels and 37 were found to be unfit to the success criterion. This shows that 82.8% of students fitted to the different van Hiele levels while the remaining 17.2% of students were found unfit to van Hiele levels. The table shows the distribution of fitted students on first three van Hiele levels; level 0 through level 2. As shown in table, the number of students decreases at higher levels. There were 109 students (61.2%) at visual level, 51 students (28.7%) at descriptive/ analytic level and only 18 students (10.1%) at informal deduction level.

The figures indicate that a great number of students (61.2%) limited to level 0 and 28.7% students attained level 1 (Descriptive analytic level). Only 10.1% students were found to be at level 2 (informal deduction). According to the van Hiele researchers (Mayberrry, 1983; Fuys, Geddles and Tischler, 1988; Usiskin, 1992; Hoffer, 1993) level 2 thinking is needed to inter in to the proof course in geometry. Such situation indicates

that a great number of students were found to be below the level required to study formal proofs in secondary geometry. Only 10.1% of students were found at level 2 which is required to study proofs.

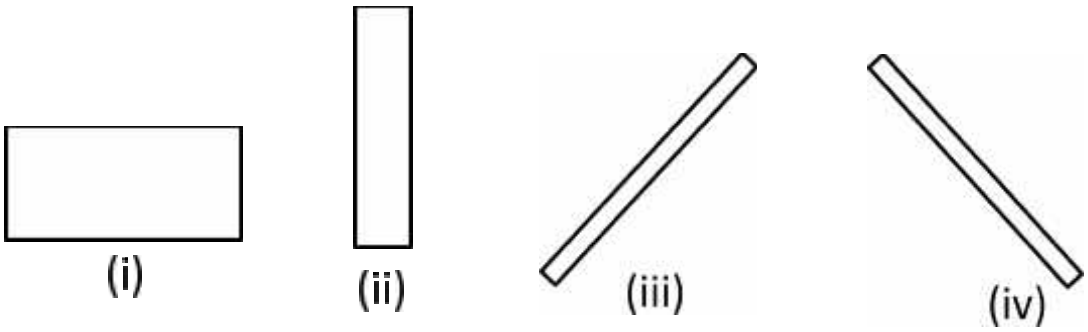
Analysis of Data Obtained From Interview

A semi structured interview was carried out on 20 students selected from the sample of the study. For interview, the researcher made use of questions as shown in appendix II. At the time of interview researcher noted students' level of thinking, learning difficulty, vocabulary used and misconceptions. At the time of interview the researcher provided paper, pencil, geometric instruments if needed and the students were asked to answer the questions by measuring, drawing etc. Analysis was made in terms of the main misconceptions since the misconceptions were found in orientation of shapes, understanding of the definition, angle concept and class inclusion relations.

Orientation of Shapes

"Geometric shapes presented in non-standard form are hardly recognized by many students, as they perceive a square in not a square if it is not a horizontal base" Fischbein and Nachlieli (1998). The orientation related misconceptions was assessed by asking to identify square, rectangles etc., which were not given in standard position. Among the seven questions asked in interview 1, 2 and 3 were intended to assess orientation of shapes (vide Appendix III). One of the questions among them is given below.

-Which of the following is/are rectangle(s)? Explain why?



The result revealed that only 9 students (45%) identified geometric shapes correctly which were given without horizontal base but only 6 of them gave explanation satisfactorily. Eleven students (55%) could not identify even thin shape with horizontal base. For example fig(ii) was not recognized as rectangle by many students where as they identify that fig(i) is rectangle. After letting the students to rotate the figures, measure the figures, seven of them could correct their answer where as 4 of them could not correct their answer even after the above intervention. This shows that majority of students had misconceptions related to orientation of shapes which is related to level 0(Visual level). They describe a figure in a look like manner. They responded that geometric figures can be determined by their appearance in standard form. Figures presented in non standard form were not well recognized by majority of the students. They seem to have misconceptions regarding orientation of geometric shapes. Some sample responses of students on above question were: "*fig(i)and (ii)are rectangles, because they looked like a rectangle. But the thinner shapes cannot be rectangle because they look like a stick.*"

On the whole more than 55% of students could not identify the simple geometric shapes (eg. Square not given on standard position). Categorically speaking, only 40% of students were able to recognize square on non horizontal base, 75% of them could not

correctly identified rectangles of thin shape, while 20% of recognized right angles in all orientations.

Understanding the Definition

Definition is a basic element in formal mathematics system. A definition is a general statement which gives us a way of recognizing the object named and a way of distinguishing it from the other objects (Kelley and Ladd, 1986). Furthermore, Marchis (2012) pointed out that students have misconceptions in geometry because of concept of definition. Formal concept definition generates personal concept image. Marchis (2012) asserted that this concept image may not develop in some students, and in others, it may not be related to the formal definition. Archavsky and Goldenberg (2005) found that there has often been conflict between mental images of geometric figures and verbal definitions. There is the need to address these misconceptions when teaching so that it would help the students reflect on where the confusion between the verbal definition and their own mental image comes from (Marchis, 2012). Research has shown that when classifying and identifying shapes preference is given to visual prototype rather than a formal definition (e.g. Ozerem, 2012). To access the students' understanding of definition of geometric shapes, the researcher gave two definitions in the form of questions as:

-Fill in the blanks:

i) *A quadrilateral having all side equal is called …… (square/ rhombus)*

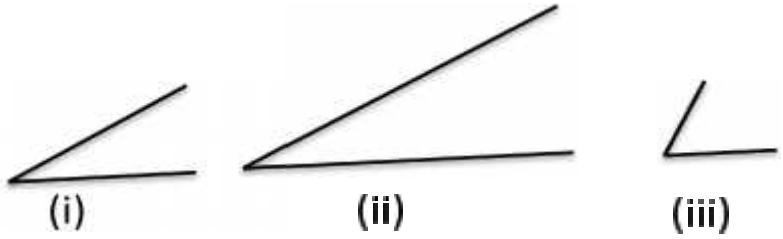
ii) A quadrilateral having opposite sides parallel and one angle right is called…….(parallelogram/ rectangle)

As the result it is seen that 7(35%) students answered the correctly for the item no. (i) which is given above. Other 13 (65%) students could not fill the blank with correct

answer. Similarly, 9 (45%) students answered the second question given above; whereas 11 (55%) could not give the right answer. Such situation shows that definition was not properly understood by majority of eight grade students.

Angle Concept

The misconception is frequently held by pupils as there is a practical illusion between larger turn and a larger space between two lines making the angle. Despite the fact that similar angles are drawn on squared paper can lead a pupil to making this judgment. To assess such misconception, the students were asked to compare the following angles in figures (i), (ii) and (iii).



It was asked to 20 students. Among them 2 students (10%) could identify correctly. They mentioned that angles in (i) and (ii) as equal though being arms longer or shorter. The angle in (iii) is greater than that of (i) and (ii) although its arms being shorter. Most of the remaining students could not correctly identify the size of the angles. They mentioned that angle in (ii) was bigger because the two arms forming the angle occupies the larger space between them. Some of responses of students on above question were: "*the smallest angle is fig(iii) and the biggest is (ii), because of the arms on them*". After some guided questioning four of them among the students asked permission for using protractor to measure the angles and after measurement they replied correctly. After letting the students to measure the sizes of angles, ten more students could correct

their answer whereas rest 4 of them could not even measure the angles. It is found from the interview that most of the students judge the geometric figures on the basis of their appearance which is the misconception of level 0 (visual level).

Class inclusion relations

Many students have problems in perceiving class inclusions of shapes, for example, they do not think that a square is a rectangle, or a square is a rhombus, and a rectangle is a parallelogram (Mayberry, 1983; Feza & Webb, 2005; Marchis, 2008). The students were asked the following questions related to class inclusion of shapes.

Which of the following statement is correct and which is incorrect? Explain why?

a) All rectangles are also parallelograms
b) All parallelograms are also rectangles
c) Only some of the rectangles are parallelograms
d) There is no rectangle which is also a parallelogram,
e) None of the above relation is true.

Students were asked to identify the correct statement with justification. As a result only 3 (15%) students out of 20 selected the correct statements that all rectangles are also parallelograms, but only two of them explained why the rectangles were parallelograms. Out of 17(85%) students who could not identify the correct response, five of them were able to give correct response after they were asked to review definition and properties of rectangle and parallelogram. Most of the students' who cannot understand class inclusion relation were responded *"rectangle is rectangle and parallelogram is parallelogram is*

parallelogram. No rectangles are parallelograms and no parallelograms are rectangles."

Such situation reflected that majority of students did not have conception of class inclusion (level 2) thinking and the situation can be improved by providing appropriate instruction. On the whole, majority of students (more than 50% of students) seemed to have misconceptions in orientation of shapes and angle measures. Majority of students were not found to follow the significance of definition and class inclusion was perceived by a few.

Chapter-V

SUMMARY, FINDINGS, CONCLUSION AND RECOMMENDATION

This chapter is devoted to summary, findings, conclusions and recommendations of the study. It begins from summary of the study followed by findings, conclusions and recommendations.

Summary of the Study

This is the first section of this chapter which summarizes the importance of the study, objectives of the study, procedures and methods adopted in the study. The research was mainly focused on exploration of misconceptions among lower secondary level students in geometry. The study was done to explore the misconception of lower secondary level students in geometry and classify them according to different van Hiele levels.

The descriptive survey design was supplemented by semi-structured interviews. Theory of van Hiele level of thought was considered as theoretical base of the study. A test based on misconception in geometry and semi structured interview was conducted as research tools. For the reliability of the research tool it was piloted among 25 eighth grade students of Shree Janakalyan Lower Secondary School, Budeli Dailekh.

The population of the study consists of all lower secondary level students of Chamunda resource center of Dailekh district studying in the academic year 2072. A sample of 215 students (eighth grade) consisting from 8 public schools was taken as the

sample of the study for van Hiele geometry test. And a sub sample of 20 students was selected for the interview out of the sample. The data collected from van Hiele Geometry Test (VHGT) was used to classify students into different van Hiele levels and to explore misconceptions in geometry. The data from interviews was used to explore misconceptions and to classify them on the basis of van Hiele levels of thinking.

Findings

Since the research was conducted to explore the misconceptions of lower secondary level students in geometry mainly in the respect of van Heile's level of geometric thought, the following findings were obtained.

- Out of 215 sample students, 175 fitted at different van Hiele levels where as 37 students were found to be unfit to the success criterion. Majority of students (61.2%) were limited to level 0(visual level) where as 28.7% were at level 1(descriptive/analytic) and only 10.1% students were at level 3(informal deduction).

Out of 175 students who fitted in van Hiele levels, 20 students were selected for interview. The findings of interviews were as follows:

- The result from interview shows that misconceptions at level 0 (visual level) were found more among the students. Most of the students respond the questions on the basis of physical appearances of geometric figures. They named the figures shown in interview on the basis of their orientation. When required to classify the geometric shapes, majority of them responded on the basis of visual prototype rather than their definitions. The misconceptions of level 0 are found namely on

orientation of shapes and angle concept. Among which 55% of the students found to have misconceptions related to orientation of geometric shapes. Similarly 90% of the students found to have misconceptions related to angle concept.

- On the basis of interview it was found that some of the misconceptions were found due to lack of understanding of definitions. When asked to define a square, they just told the definition on the basis of memorization but they could not recognize the minimum properties for the definition. Due to lack of understanding, 80% students were found to be unable/feeling uncomfortable in explaining "why?" with appropriate language and structure. So it is found that students were committing errors due to inadequate understanding of definitions.
- Most of the students were found to a misconception related to class inclusion. About 85% of the students were unable to understand class inclusion. Most of the students could not recognize that square is also a rectangle even with some guided questionings. After providing some clues/hints about10% of them could recognize that squares could be called rectangles.

Summing the results it is revealed that majority of students had misconceptions with respect to orientation of shapes, angle concept, understanding the definitions and class inclusion relation.

Conclusion

The research was conducted to identify and explore the misconceptions of lower Secondary level students in geometry in the line of van Hiele level of geometric thought. On the basis of findings of the study following conclusions were made.

It is revealed from the van Hiele geometry test that majority of the students have not had minimum intended level of understanding in geometry. 61.2% of the students were limited to visual level, where 28.7% were at descriptive/ analytic and 10.1% at informal deduction level. Most of the misconceptions found on the students belonged to visual and descriptive levels. Almost students found to have misconceptions on class inclusions. More than three fourth of interviewed students were limited to visual level, so that they could not reply the questions satisfactorily with reasons. The response of students in the interview indicates that they have much difficulty in understanding the definition. On the whole, Majority of eighth grade students suffered from misconceptions in geometric properties which are supposed to be fundamental in geometry.

Recommendation

On the basis of finding and conclusion of the research work, following recommendations has been made for the educational implication.

- Since the great majority of students have found to have no proper understanding of basic geometric concepts as identified as van Hiele test, proper understanding can be developed by incorporating van Hiele strategy in teaching geometry and developing geometry curriculum.
- Since this study was survey study supplemented with semi-structured interviews to some limited extents, other studies should be conducted which involve tests, classroom observations and detail clinical interviews comparatively with wider coverage of students.
- Teachers should be made more aware of students' misconceptions so that they could develop teaching to address students' misconceptions in geometry.

- The curriculum should give sufficient emphasis to the van Hiele level of geometric thinking at elementary level.
- Study of such kind should also be conducted at different level.
- This research is being limited in many respects (such as sample size, tools used, students coverage, levels of thinking etc.) further studies should be made more intensively with wider coverage.

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APPENDICES

Appendix-I

VAN HIELE GEOMETRY TEST (English Version)

DIRECTIONS

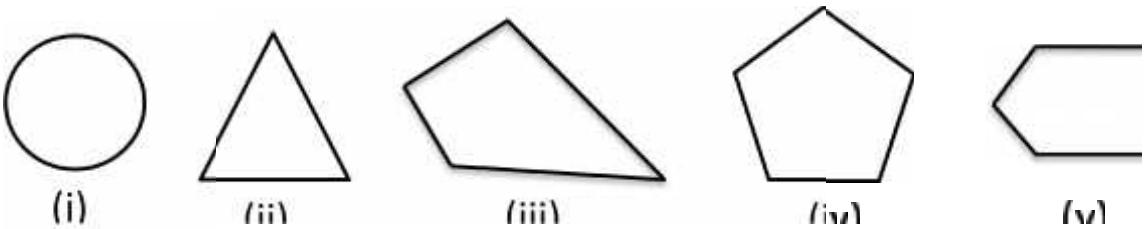
This test contains 20 questions based on students reasoning in geometry at lower secondary level

Among the five answers given to each questions, only one is correct. When you are told to begin:

1. Read the question carefully and tick the letter corresponding to your answer you think correct on your sheet.
2. Use the plane sheet provided with answer sheet for figuring and drawing, if needed.
3. If you want to change your answer, cross out the first answer and tick the one you think correct.
4. Try to answer all questions.
5. You will have 35 minutes for the test.

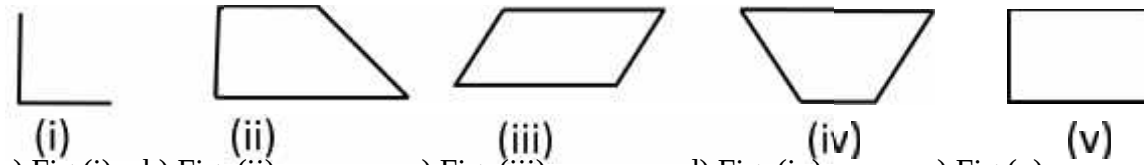
VAN HIELE GEOMETRY TEST

1. Which of these is quadrilateral?



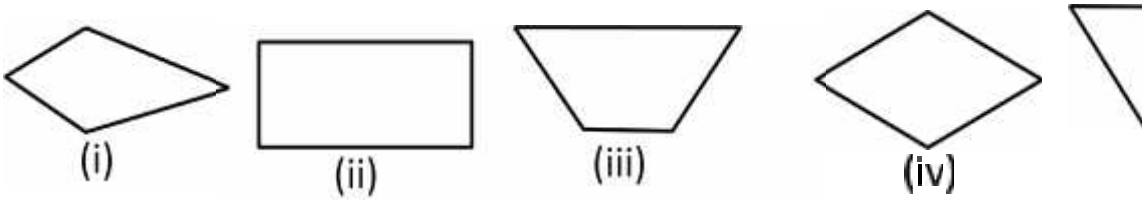
a) Fig.(i) b) Fig. (ii) c) Fig. (iii) d) Fig. (iv) e) Fig.(v)

2. Which is rectangle?



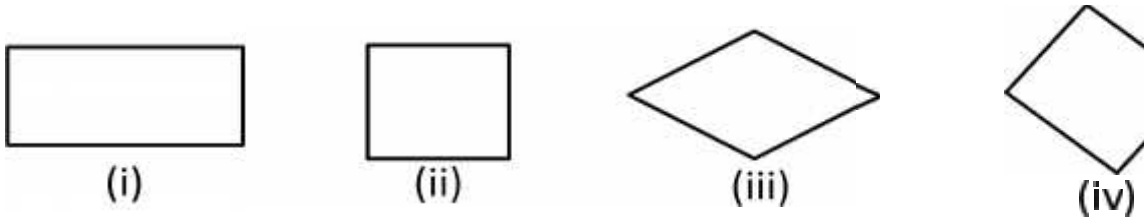
a) Fig.(i) b) Fig. (ii) c) Fig. (iii) d) Fig. (iv) e) Fig.(v)

3. Which is rhombus?



a) Fig.(i) b) Fig. (ii) c) Fig. (iii) d) Fig. (iv) e) Fig.(v)

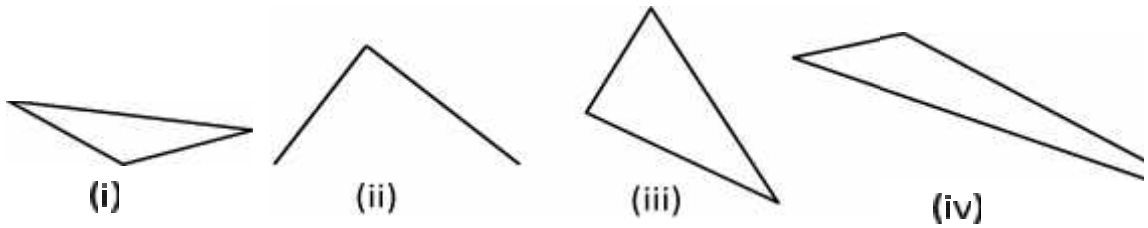
4. Which of these are squares?



a) Fig.(i) only b) Fig. (ii) only c) Fig. (i) & (ii) only

d) Fig.(ii) & (iv) only e) Fig. (iii) & (iv) only

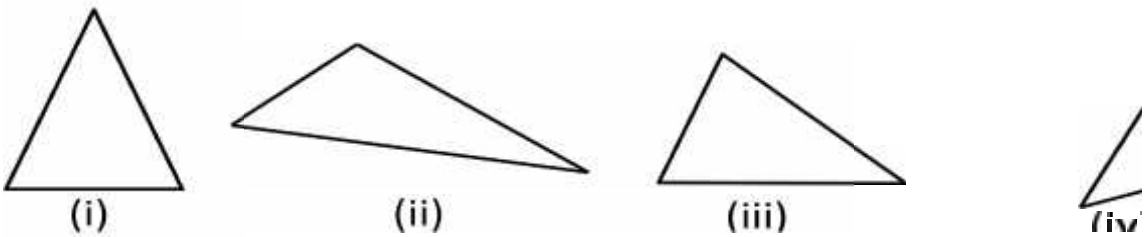
5. Which of these are triangles?



a) Fig.(i) only b) Fig. (i) & (ii) only c) Fig. (i) & (iii) only

d) Fig. (i), (iii) & (iv) only e) All figures except (iv)

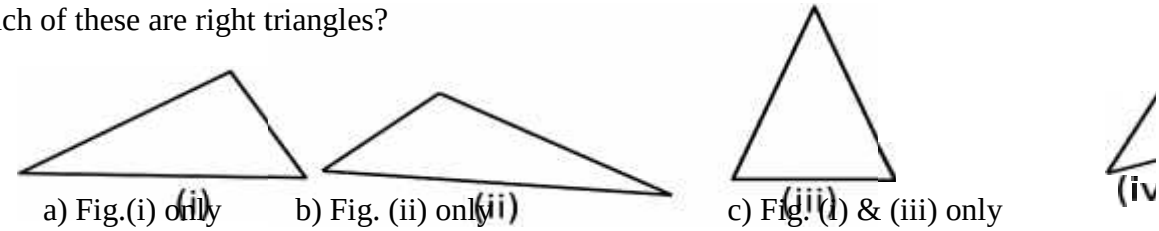
6. Which of these are isosceles triangles?



a) Fig.(i) only b) Fig (ii) only c) Fig. (ii) & (iv) only

d) Fig. (i) & (iii) only e) Fig. (ii) & (iii) only

7. Which of these are right triangles?



a) Fig.(i) only b) Fig. (ii) only c) Fig. (i) & (iii) only

d) Fig. (ii)& (iv) only e) None of the above

8. Which of these are angles?

a) Fig.(i) only b) Fig. (ii) only c) Fig. (i) & (iii) only

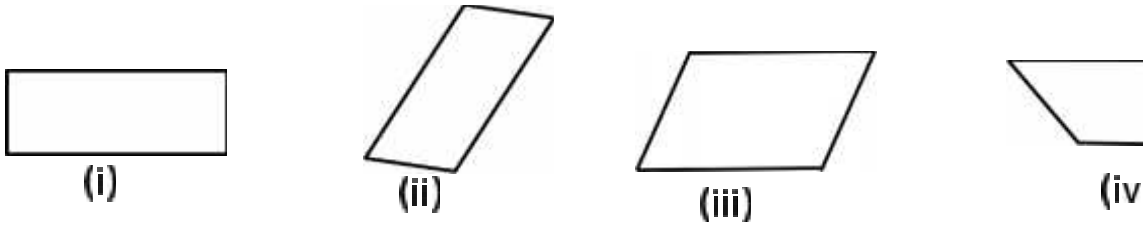
d) Fig. (iii) & (iv) only e) All figures are

angles

9. A figure has the following properties:

- It is a quadrilateral
- It has all angles equal
- It has all sides equal

Which of the following figure possesses these all properties?



a) Fig.(i) b) Fig. (ii) c) Fig. (iii)

d) Fig. (iv) e)None of the above

10. Which of the following is not a property of rectangle?

a) Opposite sides are equal b) Opposite angles are equal

c) Diagonals are equal d) Adjacent sides are equal

e) All angles are equal

11. If a quadrilateral is such that it has:

(i) All sides equal (ii) All angles equal and

(iii) Each angle is right angle.

Such kind of quadrilateral is called

a) Rectangle b) Parallelogram c) Rhombus d) Square e) trapezoid

12. A set of quadrilateral is such that each of them has:

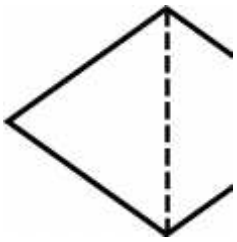
(i) Opposite sides parallel (ii) Opposite sides equal and

(iii) Opposite angles are equal but not right angles

Such kind of quadrilateral is called

a) trapezoid b) Rectangle c) Rhombus d) Square e) Parallelogram

13. What kinds of triangles can be formed by joining a diagonal in any rhombus?



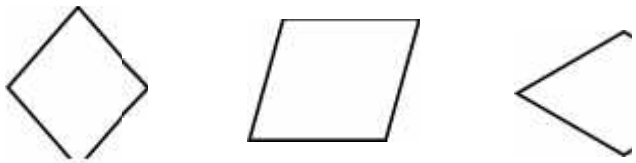
a) Scalene triangle b) Equilateral triangle only

c) Isosceles triangle d) Isosceles or equilateral triangle

e) All of the above

14. A rhombus is a 4- sided figure with all sides of the same length.

Here are three examples.



Which of the following is <u>not</u> true in every rhombus?

a) The two diagonals have the same length.

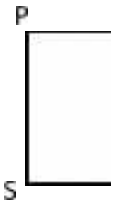
b) Each diagonal bisects two angles of the rhombus.

c) The two diagonals are perpendicular.

d) The opposite angles have the same measure.

e) All of the above are true in every rhombus.

15. PQRS is a square. Which relationship is true in all squares?



a) PR and RS have the same length

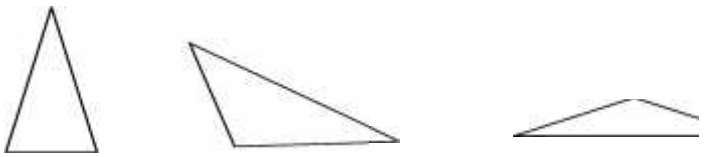
b) QS and PR are perpendicular

c) PS and QR are perpendicular

d) PS and QS have the same length

e) Angle Q is larger than angle R

16. An isosceles triangle is a triangle with two sides of equal length. Here are three examples



Which of the following statement is true in every isosceles triangle

a) The three sides must have the same length

b) One side must have twice the length of another side

c) There must be at least two angles with the same measure

d) The three angles must have the same measure

e) None of the above statement is true in every isosceles triangle

17. Each rectangle has the following properties:

i) It has four sides

ii) It has four right angles

ii) It has opposite sides are equal

iv) It has opposite angles equal

If you have to select minimum properties to characterize the rectangle well, which of the following would you select?

a) (i) & (ii) only b) (i) & (iii) only c) (i) & (iv) only

d) (iii) & (iv) only e) (i), (ii) & (iii)

18. Which of the following is the correct definition of the square in terms of parallelogram?
    a) A square is a parallelogram whose diagonals are equal
    b) A square is a parallelogram whose each angle is right and diagonals are equal
    c) A square is a parallelogram whose each angle is right and adjacent sides are equal
    d) A square is a parallelogram whose all sides are equal
    e) A square is a parallelogram whose adjacent sides are equal and opposite angles are equal
19. Which of the following relation is true between parallelogram and rectangle?
    a) All rectangles are also parallelograms
    b) All parallelograms are also rectangles
    c) Only some of the rectangles are parallelograms
    d) There is no rectangle which is also a parallelogram,
    e) None of the above relation is true.

20. Which is true statement?
    a) All isosceles triangles are also equilateral triangles
    b) All equilateral triangles are also isosceles triangles
    c) Some equilateral triangles are also isosceles triangles

d) No equilateral triangle can be an isosceles triangle

e) No equilateral triangle can be an isosceles triangle and no isosceles triangle can be an equilateral triangle.

Name of Student:

School:

Appendix-II

VAN HIELE GEOMETRY TEST (Nepali Version)

परिक्षाको लागि निर्देशन

यो Test मा २० वटा प्रश्नहरु शमाबेश गरिएको छ । दिईएका ५ उत्तर मध्ये एउटा मात्र सहि छ ।

Test सुरु गर्नपर्व ध्यान दिनुपर्ने कुराहरु:

6. दिईएका प्रश्नहरु राम्रोसग पढिसकेपछि सहि उत्तरमा (√) चिन्ह लगाउनुहोस्

7. चित्र कोर्नुपरेमा वा रफ गर्नुपर्ने भएमा प्रश्नपत्रसगै दिइएको खालि पेज प्रयोग गर्नुहोला

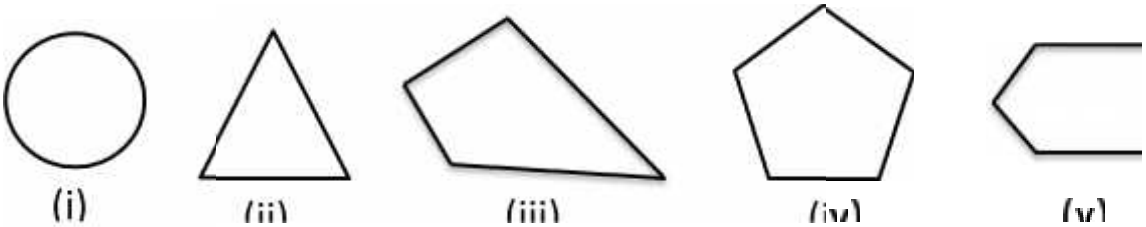
8. यदि उत्तर परिबर्तन गर्न चाहनुहुन्छ भने पहिले चिन्ह लगाएको उत्तरलाई (X) चिन्ह लगाई सहि उतरमा (√) चिन्ह लगाउनुहोस

9. सबै प्रश्नहरुको उत्तर दिने प्रयास गर्नुहोला

10. तपाईले जम्मा ३५ मिनेट समय पाउनु हुनेछ

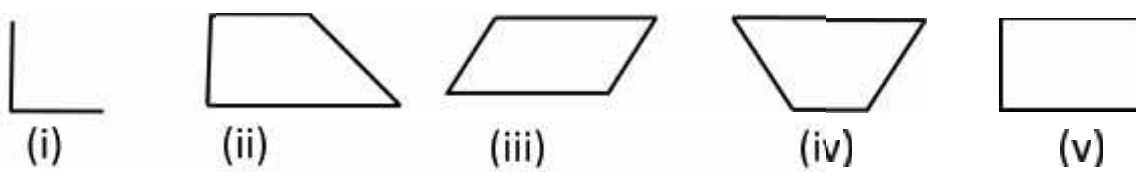
VAN HIELE TEST

1. तलका चित्रहरु मध्ये चतुर्भुज कुन हो ?



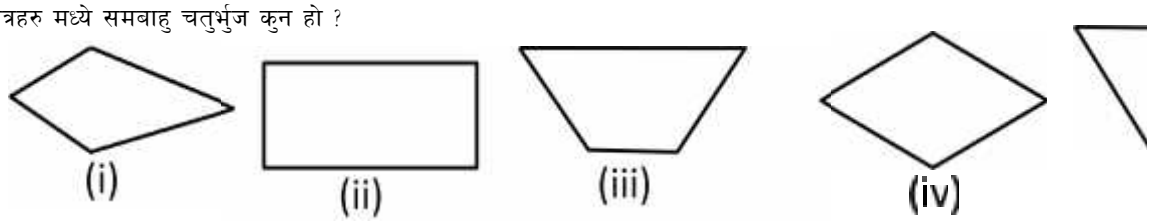
a) चित्र (i) b) चित्र (ii) c) चित्र (iii) d) चित्र (iv) e) चित्र (v)

2. तलका चित्रहरु मध्ये आयत कुन हो ?



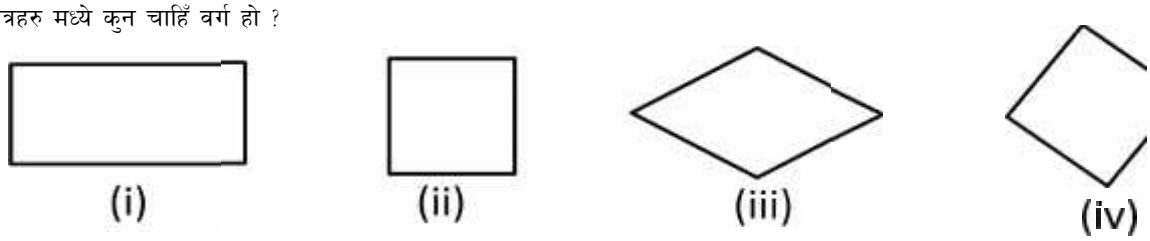
a) चित्र (i) b) चित्र (ii) c) चित्र (iii) d) चित्र (iv) e) चित्र (v)

3. तलका चित्रहरु मध्ये समबाहु चतुर्भुज कुन हो ?



a) चित्र (i) b) चित्र. (ii) c) चित्र. (iii) d) चित्र. (iv) e) चित्र. (v)

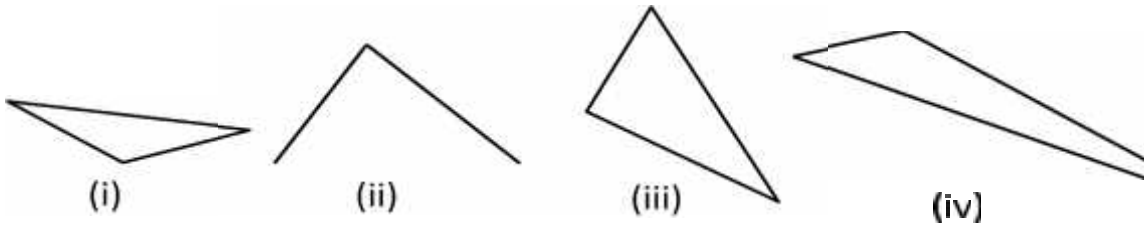
4. तलका चित्रहरु मध्ये कुन चाहिँ वर्ग हो ?



a) चित्र (i) मात्र b) चित्र (ii) मात्र c) चित्र (i) र (ii) मात्र

d) चित्र (ii) र (iv) मात्रe) चित्र (iii) र (iv) मात्र

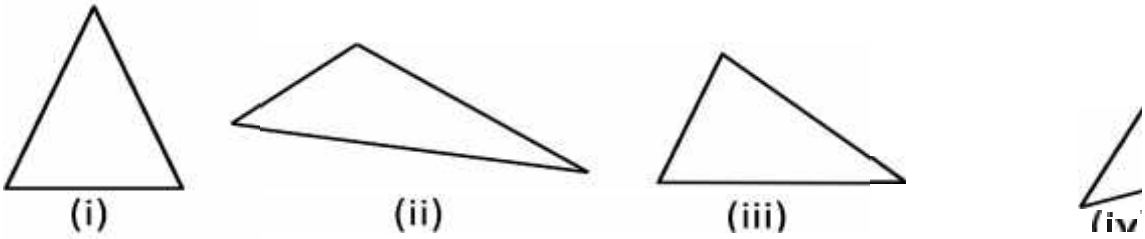
5. तलका मध्ये कुन-कुन चित्रहरु त्रिभुज हुन्?



a) चित्र (i) मात्र b) चित्र (i) र (ii) मात्र c) चित्र (i) र (iii) मात्र

d) चित्र (i), (iii) र (iv) मात्र e) चित्र (iv) बाहेक अरु सबै

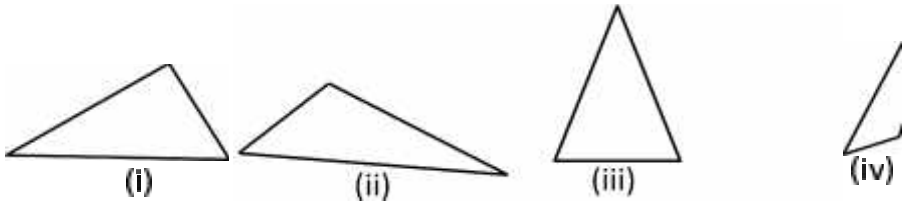
6. तलका मध्ये कुन-कुन चित्रहरु समद्विबाहु त्रिभुज हुन्?



a) चित्र (i) मात्र b) चित्र (ii) मात्र c) चित्र (ii) र (iv) मात्र

d) चित्र (i) र (iii) मात्र e) चित्र (ii) र (iii) मात्र

7. तलका मध्ये कुन-कुन चित्रहरु समकोण त्रिभुज हुन्?



a) चित्र (i) मात्र b) चित्र (ii) मात्र c) चित्र (i) र (iii) मात्र

d) चित्र (ii) र (iv) मात्र e) माथिका कुनै पनि होइनन्

8. तलका मध्ये कुन-कुन चित्रहरु कोण हुन्?

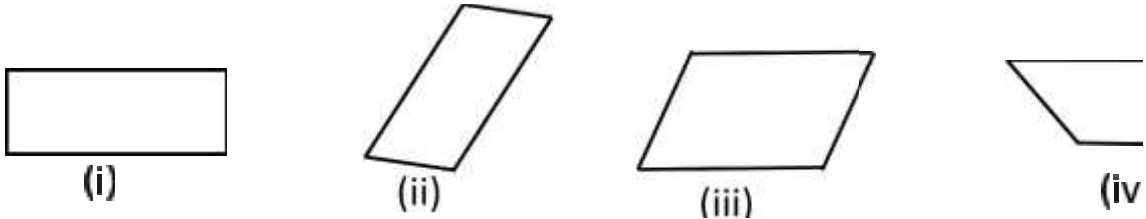
a) चित्र (i) मात्र b) चित्र (ii) मात्र c) चित्र (i) र (iii) मात्र

d) चित्र (iii) र (iv) मात्र e) माथिका सबै

9. एउटा चित्रमा तलका गुणहरु छन्:

- यो एउटा चतुर्भुज हो
- यसका सबै कोणहरु बराबर छन्
- यसका सबै भूजाहरु बराबर छन्

माथि उल्लिखित सबै गुणहरु भएको चित्र तलका मध्ये कुन हो ?



a) चित्र (i) b) चित्र. (ii) c) चित्र. (iii) d) चित्र. (iv) e) माथिका कुनै पनि होइनन्.

10. तलका मध्ये कुन चाँहि आयतको गुण होइन ?

a) सम्मुख भूजाहरु बराबर हुन्छन् b) सम्मुख कोणहरु बराबर हुन्छन्

c) बिकर्णहरु बराबर हुन्छन् d) आसन्न भूजाहरु बराबर हुन्छन्

e) सबै कोणहरु बराबर हुन्छन्

11. कुनै एउटा चतुर्भूजमा तलका गुण छन्:

(i) सम्मुख भूजाहरु समानान्तर छन् (ii) सम्मुख भूजाहरु बराबर छन् र

(iii)सम्मुख भूजाहरु बराबर छन् तर आपसमा लम्ब छैनन्, भने,

माथि उल्लिखित सबै गुण भएको चतुर्भजलाई के भनिन्छ ?

a) आयत b) समानान्तर चतुर्भुज c) समवाहु चतुर्भुज d) बर्ग e) समलम्ब चतुर्भुज

12. कुनै एउटा चतुर्भूजमा तलका गुणहरु छन्:

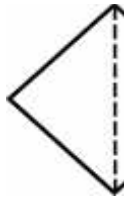
(i) सबै भूजाहरु बराबर छन् (ii) सबै कोणहरु बराबर छन् र

(iii)प्रत्येक कोण समकोण छ

माथि उल्लिखित सबै गुणहरु भएको चित्रलाइ के भनिन्छ ?

a) समलम्ब चतुर्भुज b) आयत c) बर्ग d) समवाहु चतुर्भुज e) समानान्तर चतुर्भुज

13. कुनैपनि समवाहु चतुर्भुजका विकर्णहरुलाई जोड्दा तलका मध्ये कुन त्रिभूज बन्दछ ?

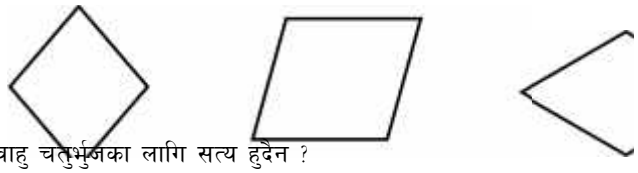


a) विसमवाहु त्रिभूज b) विसमवाहु त्रिभूज मात्र

c) समद्विवाहु त्रिभूज मात्र d) समद्विवाहु वा समवाहु त्रिभूज

e)माथिका सबै

14. समवाहु चतुर्भुज एउटा चार बराबर भूजाले बनेको बन्द आकृति हो । तल केही उदाहरणहरु दिइएको छ,



तलका मध्ये कुन तथ्य हरेक समवाहु चतुर्भुजका लागि सत्य हुदैन ?

a) बिकर्णहरु बराबर हुन्छन्

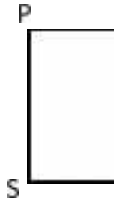
b) प्रत्येक बिकर्णले दईवटा कोणलाई समद्विभाजन गर्दछ

c) बिकर्णहरु आपसमा लम्ब हुन्छन्

d) सम्मुख कोणहरु बराबर हुन्छन

e) माधिका सबै

15. दिइएको वर्ग PQRS मा तलका मध्ये कुन तथ्य सही छ ?



a) PR र RS को लम्बाइ बराबर छ

b) QS र PR आपसमा लम्ब छन्

c) PS र QR आपसमा लम्ब छन्

d) PS र QS को लम्बाइ बराबर छ

e) कोण Q कोण R भन्दा ठूलो छ

16. कुनै दुई वटा भूजा बराबर भएको त्रिभूज समद्विवाहु त्रिभूज हो । चित्रमा तीन वटा उदाहरण दिइएको छ ।

तलका मध्ये कुन चाँहि तथ्य (A) – (D) सबै समद्विवाहु त्रिभूजका लागि सहि हुन्छ ?

a) तिन वटै भूजाको लम्बाइ बराबर हुनुपर्छ

b) एउटा भूजा अर्को भूजाको दोब्बर हुनुपर्छ

c) कम्तिमा दुईवटा कोणहरु बराबर हुनुपर्छ

d) तीन वटै कोणहरु बराबर हुनुपर्छ

e) माथिका कुनैपनि तथ्य समद्विवाहु त्रिभूजका लागि सत्य हुँदैनन्

17. हरेक आयतमा निम्न गुणहरु हुन्छन् ।

i) चार वटा भूजा हुन्छन्

ii) चार वटा समकोण हुन्छन्

iii) विपरित भूजाहरु समानान्तर हुन्छन्

iv) विपरित भूजाहरु बराबर हुन्छन्

यदि सबैभन्दा कम गुणहरु प्रयोग गरि आयतआई परिभाषित गर्नको लागि तलका मध्ये कुन उपयुक्त हुन्छ ?

a) (i) र (ii) मात्र

b) (i) र (iii) मात्र

c) (i) र (iv) मात्र

d) (iii) र (iv) मात्र

e) (i), (ii) र (iv)

18. तलका मध्ये कुन भनाई सत्य छ ?

a) विकर्णहरु बराबर भएको समानान्तर चतुर्भज बर्ग हो

b) हरेक कोण समकोण भई विकर्णहरु बराबर भएको समानान्तर चतुर्भज बर्ग हो

c) हरेक कोण समकोण र आसन्न भुजाहरु बराबर भएको समानान्तर चतुर्भज बर्ग हो

d) सबै भुजाहरु बराबर भएको समानान्तर चतुर्भज बर्ग हो

e) आसन्न भुजाहरु बराबर भएको र सम्मुख कोणहरु बराबर भएको चतुर्भज बर्ग हो

19. तलका मध्ये कुन सम्बन्ध सत्य छ ?

a) सबै आयतहरु समानान्तर चतुर्भुज हुन्

b) सबै समानान्तर चतुर्भुजहरु आयत हुन्

c) केही आयतहरु मात्र समानान्तर चतुर्भुज हुन

d) कुनैपनि आयत समानान्तर चतुर्भुज होइन

e) माथिका कुनै पनि सम्बन्ध सत्य छैन

20. तलका मध्ये कुन कथन सत्य छ ?

a) सबै समद्विवाहु त्रिभूजहरु समवाहु त्रिभूज हुन्

b) सबै समवाहु त्रिभूजहरु समद्विवाहु त्रिभूज हुन्

c) कही समवाहु त्रिभूजहरु समद्विवाहु त्रिभूज पनि हुन

d) कुनैपनि समवाहु त्रिभूज समद्विवाहु त्रिभूज हुन सक्दैन

e) कुनैपनि समवाहु त्रिभूज समद्विवाहु त्रिभूज हुन सक्दैन र कुनैपनि समद्विवाहु त्रिभूज समवाहु त्रिभूज हुन सक्दैन ।

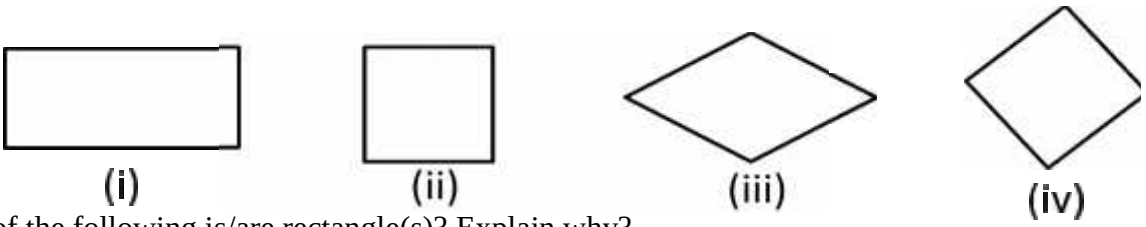
विद्यार्थिको नामः

विद्यालयको नामः

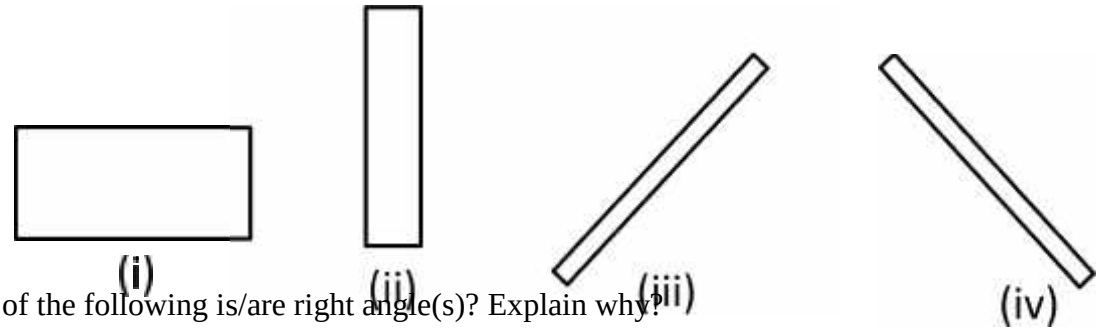
Appendix-III

Interview Schedule (English Version)

1. Which of the following is/are square(s)? How do you know?

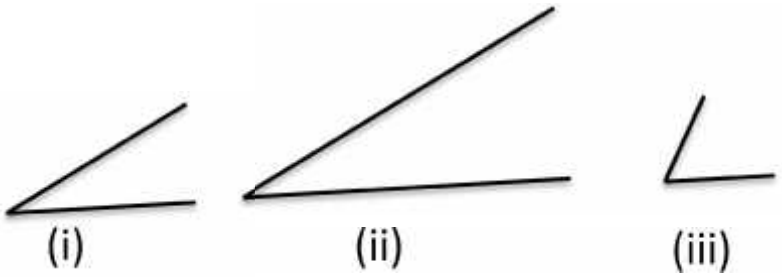


2. Which of the following is/are rectangle(s)? Explain why?



3. Which of the following is/are right angle(s)? Explain why?

4. Compare the following angles (for equality, or one smaller or one greater than another)?



5. Which of the following statement <u>is not true</u> for all rectangles? Explain why?

    a) All angles are equal

    b) All sides are equal

    c) Adjacent sides are equal

    d) Diagonals are equal

    e) All of the above are true.

6. Which of the following statement is correct? Which is incorrect? And why?

    a) All rectangles are also parallelograms

    b) All parallelograms are also rectangles

    c) Only some of the rectangles are parallelograms

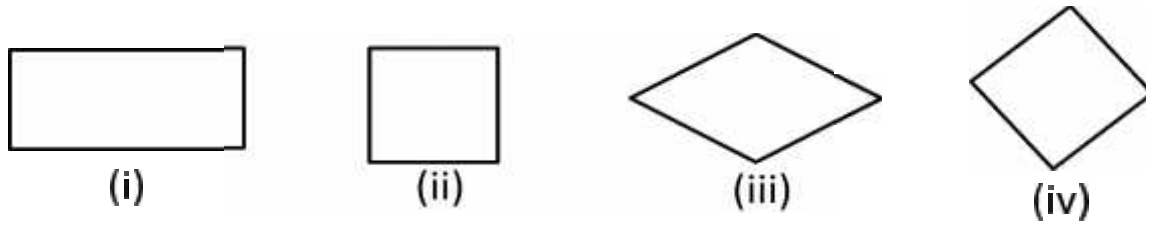
    d) There is no rectangle which is also a parallelogram,

    e) None of the above relation is true.

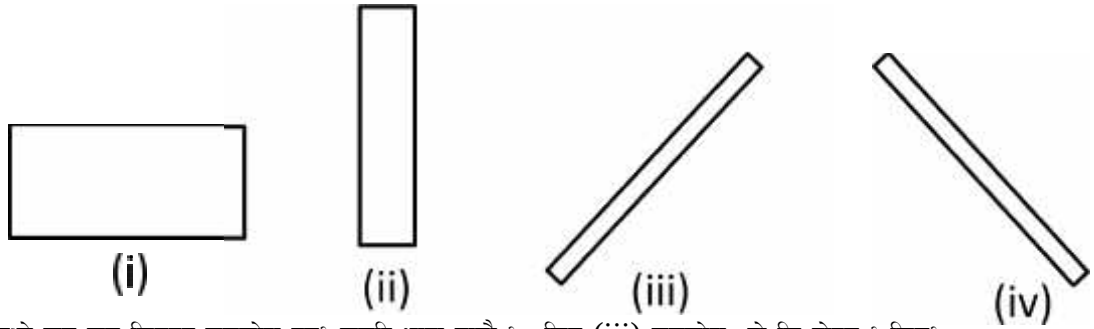
Appendix-IV

Interview Schedule (Nepali Version)

1. तलका चित्रहरु मध्ये कुन चाहिँ वर्ग हो ?कसरि थाहा पायौ ?

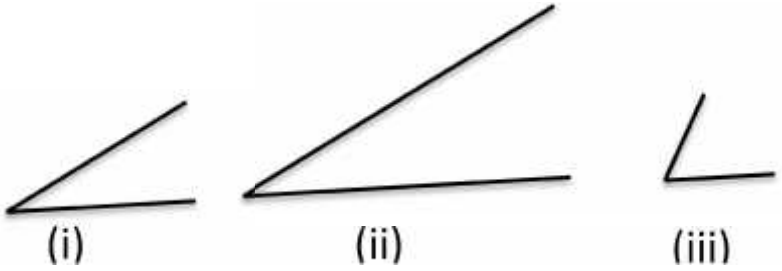


2. तलका चित्रहरु मध्ये कुन चाहिँ आयतहरु हुन्? कसरि थाहा पायौ ? किन?



3. तलका मध्ये कुन-कुन चित्रहरु समकोण हुन्? कसरि थाहा पायौ ?, चित्र (iii) समकोण हो कि होइन ? किन?

4. तलका कोणहरु लाई तुलना गर (सानो, ठुलो वा बराबर)



5. कुनैपनि आयतमा तलका मध्ये कून कून कथन सत्य छैन ? पुष्टी गर .

a) सबै कोणहरु बराबर छन् ।

b) सबै भूजाहरु बराबर छन् ।

c) आसन्न भूजाहरु बराबर हुन्छन् ।

d) बिकर्णहरु बराबर हुन्छन् ।

e) माथिका सबै कथन सत्य छन् ।

6. तलका मध्ये कून कून भनाई सत्य हुन्छ ? पुष्टी गर ।

a) सबै आयतहरु समानान्तर चतुर्भुज हुन् ।

b) सबै समानान्तर चतुर्भुजहरु आयत हुन् ।

c) केही आयतहरु मात्र समानान्तर चतुर्भुज हुन् ।

d) कुनैपनि आयत समानान्तर चतुर्भुज होइनन् ।

e) माथिको कुनै पनि सम्बन्ध सत्य छैन ।