EFFECTIVENESS OF GEOGEBRA IN TEACHING AND LEARNING

GEOMETRY

A

THESIS

BY

DIPESH PRAJAPATI

IN PARTIAL FULFILLMENT OF THE REQUIREDMENTS FOR

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LETTER FOR CERTIFICATION

This is to certify that **Mr. Dipesh Prajapati,** student of academic year **2073/074** with campus Roll No: 076, Exam Roll No: 7328352 and T.U. Registration No: **9-2-9-147-2013** has completed his thesis under supervision of Prof. Dr. Bed Prasad Dhakal during the period prescribed by the rules and regulations of Tribhuvan University, Nepal. The thesis entitled **Effectiveness of GeoGebra in Teaching and Learning Geometry** has been prepared based on the results of his investigation conducted during the period under the Department of Mathematics Education, University Campus. Tribhuvan University, Kirtipur, Kathmandu. His thesis number is **1598.** I recommend and forward his thesis for evaluation as the partial requirements to award the Degree of Master of Education.

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Date: 8 September 2021   Prof. Dr. Bed Raj Acharya

LETTER OF APPROVAL

This thesis submitted by **Mr. Dipesh Prajapati** entitled on **"Effectiveness of GeoGebra in Teaching and Learning Geometry"** has been approved as for the partial fulfillment for the requirement of Master's Degree in Mathematics Education.

Committee for the Viva-Voce   Signature

1. Prof. Dr. Bed Raj Acharya   ..………………

    (Chairman)

2. Prof. Dr. Ramjee Prasad Pandit   ………………..

    (External)

3. Prof. Dr. Bed Prasad Dhakal   ...……………..

    (Supervisor)

Date: 20 September 2021

RECCOMONDATION FOR ACCEPTANCE

This is to certify that **Mr. Dipesh Prajapati** has completed his thesis entitled **Effectiveness of GeoGebra in Teaching and Learning Geometry** under my supervision during the period prescribed by the rules and regulation of Tribhuvan University, Nepal. The study embodies the result of investigation conducting during the period under the Department of Mathematics Education, University Campus, Tribhuvan University, Kirtipur, Kathmandu. I recommend and forward his thesis to the Department of Mathematics Education for the final viva-voice.

Date: 8 September 2021 ....………………..

Dr. Bed Prasad Dhakal

(Supervisor)

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By

Dipesh Prajapati

DEDICATION

This work is heartily dedicated to my respected parents mother Renu Maya Prajapati and father Late Dhan Lal Prajapati whose support, love, care and sacrifices made me a person who I am now.

DECLARATION

This thesis does not contain any others work which is offensive and beyond the copy write norms. To the best of my knowledge and beliefs this research is truly based on my effort and it does not match with any researches that were published earlier in this university as well as others. I take all the ethical and legal responsibility for submitting this thesis.

…………………..

Dipesh Prajapati

ACKNOWLEDGEMENT

ABSTRACT

This study entitled "Effectiveness of GeoGebra in teaching and learning geometry" is an experimental research. The first objective of this study were to compare the achievement of students taught by using GeoGebra both by teacher and students versus GeoGebra used by teacher only on circle and parallelogram of grade IX, and the second objective to explore the student's perception about GeoGebra at grade IX.

This research was based on constructivist view of learning. A pre-test and post-test of quasi-experimental research design was used to find the effectiveness of GeoGebra on students' achievement. Researcher used conventional sampling and selected two schools from the Baglung district. For the research purpose, I selected 20 students from New Life Secondary Boarding School as experimental group and 18 students from Golden Future Secondary Boarding School as control group. For the data collection, I used mathematical achievement test, a set of questionnaire related to five point Likert's scales and semi-structure interview. The mathematics achievement test was used to fulfill the first objective and the set of questionnaire and semi-structure interview were used for second objective.

The results indicated that there was a significant difference between the average achievements of students taught by using GeoGebra by both teacher and students versus GeoGebra used by teacher only. The finding illustrated that the students in the experimental group performed better than the control group. Additionally, a set of questionnaire related to five point Likert's scale and interview were used on both experimental and control groups to explore the student's view about GeoGebra at grade IX. The result of questionnaire and interview showed that, students had positive perception about GeoGebra software in teaching geometry.

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ABBREVIATIONS

ICT: Information and Communication Technology

ZPD: Zone of Proximal Development

MOE: Ministry of Education

CDC: Curriculum Development Center

M.ED: Master in Education

TU: Tribhuvan University

NCTM: National Council of Teacher of Mathematics

i.e.: That is

P: Difficult level

D: Discrimination index

t: t-distribution

%: Percentage

S.D: Standard deviation

s. n.: students' number

T. S.: Total Score

O. I.: Odd Items

E. I.: Even Items

Chapter I

INTRODUCTION

Background of the Study

Information and Communication Technology (ICT) refers to use new or modern technology in any field. ICT creates the environment for the learner to learn easily from difficulty. Worldwide researches have shown that ICT can lead to improve student's learning with appropriate teaching method. It provides great opportunity for teacher and learner to improve their teaching and learning process.

In teaching and learning mathematics, especially geometry it is important for students to be able to imagine, construct and understand the construction of shapes in order to connect them with related facts. Therefore, a computer will assist students in imagining and making observations (Dogan, 2010). A number of technological tools are available now such as interactive whiteboard, graphic calculator and GeoGebra, in geometry, teaching and learning ability to construct geometric shapes, graphs, length, and concepts are important to each learner for understanding. Construction of shapes with subsequence steps in order to connect them within the required situation i.e. for meaningful learning and teacher for making geometry teaching for understanding which is influenced by teaching materials used by a teacher in the classroom. To design effective lessons in geometry for understanding and better construction, there is the availability of various computer-based software or ICT tools such as GeoGebra, Mathematica, matlap, etc. That helps teacher and student to demystify the geometric construction and concepts dynamically and in the visualization manner. In teaching and learning mathematics, especially geometry it is important for students to be able to imagine, construct and understand the construction of shapes in order to connect them with related facts. Therefore, a computer will assist students in imagining and

making observations (Dogan, 2010). A number of technological tools are available now such as interactive whiteboard, graphic calculator and GeoGebra, in geometry, teaching and learning ability to construct geometric shapes, graphs, length, and concepts are important to each learner for understanding. Construction of shapes with subsequence steps in order to connect them within the required situation i.e. for meaningful learning and teacher for making geometry teaching for understanding which is influenced by teaching materials used by a teacher in the classroom. To design effective lessons in geometry for understanding and better construction, there is the availability of various computer-based software or ICT tools such as GeoGebra, Mathematica, matlap, etc. That helps teacher and student to demystify the geometric construction and concepts dynamically and in the visualization manner.

GeoGebra was designed by Markus Hohenwater in 2001, as an open- source dynamic mathematics software that incorporates geometry, algebra and calculus into a single, open- source, user- friendly package (Hohenwarter, Jarvis, & Lavicza, 2008). This software combined features of older software programs such as Maple, Derive, Cabri and Geometer's Sketchpad (Sahaa, Ayub, &Tarmizi, 2010). GeoGebra is free and user- friendly software that connects geometry and algebra (White, 2012). GeoGebra's support materials are rather impressive (especially for a free program), where it provides wide- ranging online help feature, help manual in pdf format, downloadable tutorials, and a variety of detailed lessons using video- based step- by- step examples. These materials are very concise, easily accessible, and professionally done, with supplementary suggestions contributed by users. Furthermore, in this study, it is main teaching material to teach.

According to Hohenwarter (2008), GeoGebra is dynamic mathematic software for schools that joins geometry, algebra, and calculus, On the other hand,

GeoGebra is interactive geometry software. We can do constructions with points, vectors, segments, lines, polygons, circle, and conic sections as well as functions while changing them dynamically afterward. On the other hand, equations and coordinates can be entered directly. Thus, GeoGebra has the ability to deal with variables for numbers, vectors and points.

Statement of the Problem

The use of technology has played important role in education. Different research has shown ICT as effective tool for teaching and learning at school level. It is believed that ICT is most important factor for integrating the developing and developed countries. But use of ICT in Nepal has slown progress in the field of education. The government of Nepal, ministry of education, national information and communication technology policy (2015), shows different guide lines and goals about information and communication technology policy. Moreover, in the context of Nepal school education is based on traditional approach. Less of schools have access of ICT tool. Few mathematics teachers can't use of ICT in the classroom at school level. Tradition of paper pencil medium has made difficulty to learn geometry for the students at school level.

Now these days, different software are developed related to different subject and content. As the same ways, there are many software developed related to teaching and learning mathematics, like Mathematica, GeoGebra, graphic calculator etc. These software help to teaching and learning mathematics. Among them GeoGebra is most important tool for teaching mathematics. It is easy to use for the teacher and students. It makes teaching and learning more interesting and enjoyable.

In the context of Nepal, ICT is included as a subject (namely computer subject) at secondary level. But, it is necessary to use of ICT as tool for teaching as

well as a tool for learning. Therefore, this study conducted for to find out GeoGebra is how effective if teacher and students both used it as a tool for teaching and learning geometry in the classroom.

Furthermore, from the review of different literature (research) which were done before about the topic of effectiveness of GeoGebra. We got measure the effectiveness of GeoGebra from comparing between GeoGebra assisted instruction and without GeoGebra assisted instruction (teaching by traditional method). There, GeoGebra assisted instruction means; GeoGebra used by teacher only to show or visualize geometrical concept and problems in the classroom. But students were passive for themselves to use GeoGebra software for their learning, which is the research gap for my research. So, to fulfill this gap, I was done this research where to measure the effectiveness of GeoGebra, by comparing between; taught geometry by using GeoGebra software by both teacher and students versus using GeoGebra software by teacher only in the classroom. Thus this research is completely difference from other research. In this research students also used GeoGebra software for their learning with teacher in the mathematical classroom so there students were active learner to use GeoGebra software for learn geometrical concept and problems. Therefore, this study conducted for, to find out the effectiveness of GeoGebra software which used by teacher and students in teaching and learning geometry.

Statement of the problems as mentioned bellow:

- What is the effectiveness of GoeGebra used by both teacher and students in teaching and learning geometry?

- What is the student's perception about the GeoGebra in teaching geometry?

Significance of the Study

More students think mathematics as the difficult subject for the study. The achievement of mathematics result shows poor in different data of school level. The teacher and parents accept this fact about school education. So, mathematics teacher must be careful for the teaching environment and student's psychology. Mathematics subject has been taught as a compulsory subject in school education from grade I to X in the context of Nepal. The use of ICT is increasing day by day in different field. So, mathematics teaching should be ICT based.

This study would be helpful for researcher, mathematics teacher, student and policy maker. It will help to prepare plans for teacher and curriculum designer where are different abilities. It will provide an opportunity to compare the views of students and help to develop that use of ICT at school level.

More precisely, the significances of the research were as follows;

- Finding of this research would help mathematics teacher to improve their teaching strategies.

- Students might understand and visualize the problems related to circle and parallelogram.

- To manage the ICT based classroom and apply the technology in the teaching pedagogy.

- As the curriculum designer could be helped to develop the technology base curriculum.

Objectives of the Study

The main objective of this study was to investigate the effectiveness of GeoGebra for teaching and learning geometry, used by both teacher and students on the chapters of circle and parallelogram at grade IX.

More precisely the objectives of this study were as follows:

- To compare the achievement of students taught by using GeoGebra both by teacher and students versus GeoGebra used by teacher only.

- To explore the student's perception about GeoGebra at grade IX.

Research Questions

The research questions of this study were as follows:

- Are there any difference in teaching circle and parallelogram of geometry using GeoGebra by both teacher and students versus GeoGebra used by teacher only in classroom?

- How does the use of GeoGebra affect student's learning?

- What is the perception of students taught circle and parallelogram of geometry by using GeoGebra?

Research Hypothesis

The dynamic software GeoGebra which is used by both teacher and students yield effective result in terms of the achievement of mathematics than the achievement of the students taught using GeoGebra by teacher only.

Statistical Hypotheses

For my research the following null and alternative hypotheses were made;

H_0: There is no significant difference between the achievements of students taught by using GeoGebra by both teacher and students versus GeoGebra used by teacher only.

H_1: There is significant difference between the achievements of students taught by using GeoGebra by both teacher and students versus GeoGebra used by teacher only.

Delimitation of the Study

- This research was focused on the students of grade nine only.

- Only circle and parallelogram were taught during the study.

- Only private schools were selected.

Operational Definition of the key Terms

  GeoGebra. GeoGebra is a computer software package and is so named because it combines geometry and algebra as equal mathematical partners in its representations. It is dynamic mathematical software suitable for geometry teaching and learning that provide the opportunity to explore a wide variety of algebraic and geometric concepts through graphs and shapes.

  Effectiveness. It is defined in the following terms:

- Positive change in scores,

- Positive change in student's perception,

- Increase in the regularity of student in classroom,

- Increase in the rate of homework and classwork,

More precisely, in this study, effectiveness includes: Increase the average achievement in geometry and make the students familiar with GeoGebra.

  Perception. In this study perception referred to students' view or opinion according to their experience about GeoGebra after using it in geometry teaching. It is a dependent variable of the study and measured by a set of questionnaires and interview.

  Achievement. In this study, the term "Achievement" is defined in term of the score obtained by the students on the achievement test prepared by the researcher.

Chapter II
REVIEW OF RELATED LITERATURE

Literature Review

A literature review is a description of the relevant to a particular. It gives an overview of what has been said, who the key writers are, what the prevailing theories are hypotheses, what questions are being asked and what methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other finding (Cooper, 2002).

Empirical Review

I reviewed some theses, which are described in the following paragraphs.

Acharya (2020), conducted the study to determine "Effectiveness of GeoGebra in Teaching Geometry". The main objectives of this study were to compare the achievement of students taught by GeoGebra assisted teaching method and conventional teaching method on Parallelogram at grade IX, and to identify the students perception towards GeoGebra software in teaching Parallelogram. The researcher was adopted the quasi experimental design. Experimental group and control group were selected for the study. Where, 26 students were for experimental group and 26 students were for the control group. The researcher used achievement test, a set of questionnaire and interview to collect the data. The researcher used mean, standard deviation, t-test, chi-square and thematic code method for the analysis of data. After analysis of the data, GeoGebra based instruction was much better than traditional way of instruction. Also result indicated that students had positive perception towards GeoGebra software in teaching geometry.

Similarly, Bohora (2019), studies on the topic "Effectiveness of GeoGebra in teaching geometry". The main objective of this study was to investigate effectiveness

of GeoGebra in teaching geometry at grade IX. There were 27 students for experimental group and 29 students for control group. The researcher used achievement test and a set of questionnaire to collect the data. The collected data were analyzed by comparing mean, S.D and t-test with the help of SPSS software. The result of this study showed that achievement of the students in experimental group had better than that of control group. Also, from the result of questionnaire indicated that students had positive perception towards GeoGebra software in teaching geometry.

In the same way, Shrestha (2019), studies on the topic "Effectiveness of GeoGebra Software in teaching mathematics at secondary level". The main objective of the study was to find out the effectiveness of GeoGebra in teaching mathematics, and to explore the perception of students about GeoGebra. The researcher was adopted the quasi-experimental design. The researcher selected 25 students for control Group and 25 students for experimental Group. For the data collection tools, researcher used achievement test and interview. The collected data were analyzed by statistical method (mean, standard deviation and t-test) for quantitative data and used to descriptive and analytic method to analysis the data collection from interview. The findings of this research showed that there is significant different between the achievement of students taught by using GeoGebra software and conventional method in teaching mathematics at secondary level.

Likewise, Gajurel (2018), studies on the topic "Effectiveness of GeoGebra in teaching geometry at grade X". The main objective of the study was to compare the achievement of students taught by using GeoGebra assist learning method over traditional learning methods in teaching geometry and to explore the student attitude about GeoGebra. The researcher was adopted the quasi-experimental design. The

researcher selected 20 students for control Group and 16 students for experimental Group. For the data collection tools, researcher used achievement test, yes/no scale questionnaire and interview. The collected data were analyzed by mean, standard deviation and t-test for quantitative data and thematic code method for interview. The findings of this research showed that there is significant different between the achievement of students taught by using GeoGebra software and traditional method in teaching mathematics at X. Also result indicated that positive perception towards GeoGebra software in teaching geometry.

In the same manner, Lamichhane (2017), studied on the topic ''Effectiveness of GeoGebra on students' achievement in geometry''. The main objectives of the study was to investigate the effectiveness of GeoGebra Software on student achievement in circle and parallelogram of geometry at grade X. To meet the objectives of the study, the researcher used quasi- experimental design. The researchers choose 36 students as an experimental group and 39 students as a control group. Mathematics achievement test and questionnaire were data collection tools for the study. The researcher used mean, standard deviation and t-test for the analysis of data The result of this study indicated that there was a significant difference between the average achievement score of experimental and control groups on post-test, this finding illustrates that the students in the experimental group performed better when using GeoGebra than the control group with the traditional teaching method.

Also, Joshi (2017) conducted the study to determine "Student's Achievement in Trigonometry Teaching through GeoGebra". The purpose of the study was to investigate the impact of student's achievement in teaching trigonometry through using GeoGebra software. The researcher was adopted the quasi experimental design. Experimental group and control group are selected for the study, among them 20

students were for experimental group and 22 students were for the control group. The researcher uses mean, standard deviation and t-test for the analysis of data. After analysis of the data, GeoGebra based instruction is much better than traditional way of instruction.

Moreover, Bist (2017) conducted a study "Use of GeoGebra in geometric construction". The purpose of the study was to compare achievement of students taught by using GeoGebra and traditional method and explore student's attitudes to the use of GeoGebra in geometric construction. The researcher was selected two public school for experimental and control group. The researcher was used mean, standard deviation and t-test for analysis for the collected data. Pre-test, post-test and questionnaire was used for the data collection. After the data analysis, the researcher was found better achievement of the students in experimental groups than control groups.

Conclusion

GeoGebra, is dynamic geometry software, not only provides students with facilities to experiment the mathematical ideas and to associate mathematical concepts with the real-life examples, but also helps students to examine the relation between algebraic and geometrical concepts. Many studies on the effectiveness of GeoGebra indicated that GeoGebra has the positive effects on students' mathematics learning, mathematics achievement.

Use of ICT in teaching and learning mathematics is major issues. Government of Nepal has focused for the use of ICT in teaching at school level curriculum. There were many researches had done on the topics GeoGebra added instruction versus traditional teaching method but not this type of study done before. So, I am interested to search the effectiveness of the GeoGebra in teaching and learning geometry at

grade IX where GeoGebra used by teacher and students versus GeoGebra used by teacher only in the classroom. And to explore the use of GeoGebra software in teaching geometry in the classroom for the partial fulfillment of the master degree research course of TU.

Theoretical Framework of the Study

The study based upon the constructivist theory of social interaction for cognitive development because the use of ICT in teaching learning means to construct new style and knowledge based on subject matter. It was directly linked with society because new trends in education and teaching learning process help to change society. Also, for all the changing of means of teaching materials should be favour of the society. GeoGebra for the mathematical concept which gave the opportunity for all students to construct new trend of learning. The main application would anchor on the zone of proximal development (ZPD) and scaffolding. Students have general challenges in understanding the mathematical concepts. Therefore, in this study the dynamic geometrical software GeoGebra was introduced as a scaffold to improve student understanding of circle and parallelogram geometry. The ZPD is described as the variance between mental age and the level one might attain in problem solving with guidance. Scaffolding refers to guidance provided for one to reach the ZPD. In this study GeoGebra software acts as the primary scaffold in assisting and guiding the students to reach their ZPD.

Social interaction between peers gave the students opportunities to help one another and reach the level of shared understanding. Here the higher capacity students play big role for helping the lower ability students to reach their zone of proximal development ZPD. The higher capacity students also benefit through the new ideas

and views of their peers. Students were also placed in groups of four to work for constructing the diagrams.

Vygotsky's views are related to this learning environment where he emphasized that cultural environment and social interaction contribute to cognitive development (Kandel, 2017). However, this must take place within the zone of the individual's potential development. In this study, students were placed in groups where the scaffolding process can take place for them to construct geometrical figure based on what they already know and with help accepted from their peers when needed. In this environment the teacher play role as a facilitator. This manner of learning improved critical thinking skills as students contribute ideas and views to reach a common understanding. However, this process had to be closely monitored to ensure a balance in terms of input from both group members. Here the higher ability students played a big role in helping the lower ability students to reach their ZPD. The higher ability students also benefit through the insights gained from their peers. GeoGebra gave the students golden opportunity for peer interaction to understanding and visualization of the concept of circle and parallelogram in geometry.

Conceptual Framework of the Study

This section deals about the conceptual framework for the research. The conceptual framework has established on the basis of research topic possible areas to fulfill the objectives of the theoretical framework for the study. This is the process that occurs through social interaction, and students generated new knowledge building on to what the already know (Burner, 1973).

Figure 2.1: Conceptual Framework
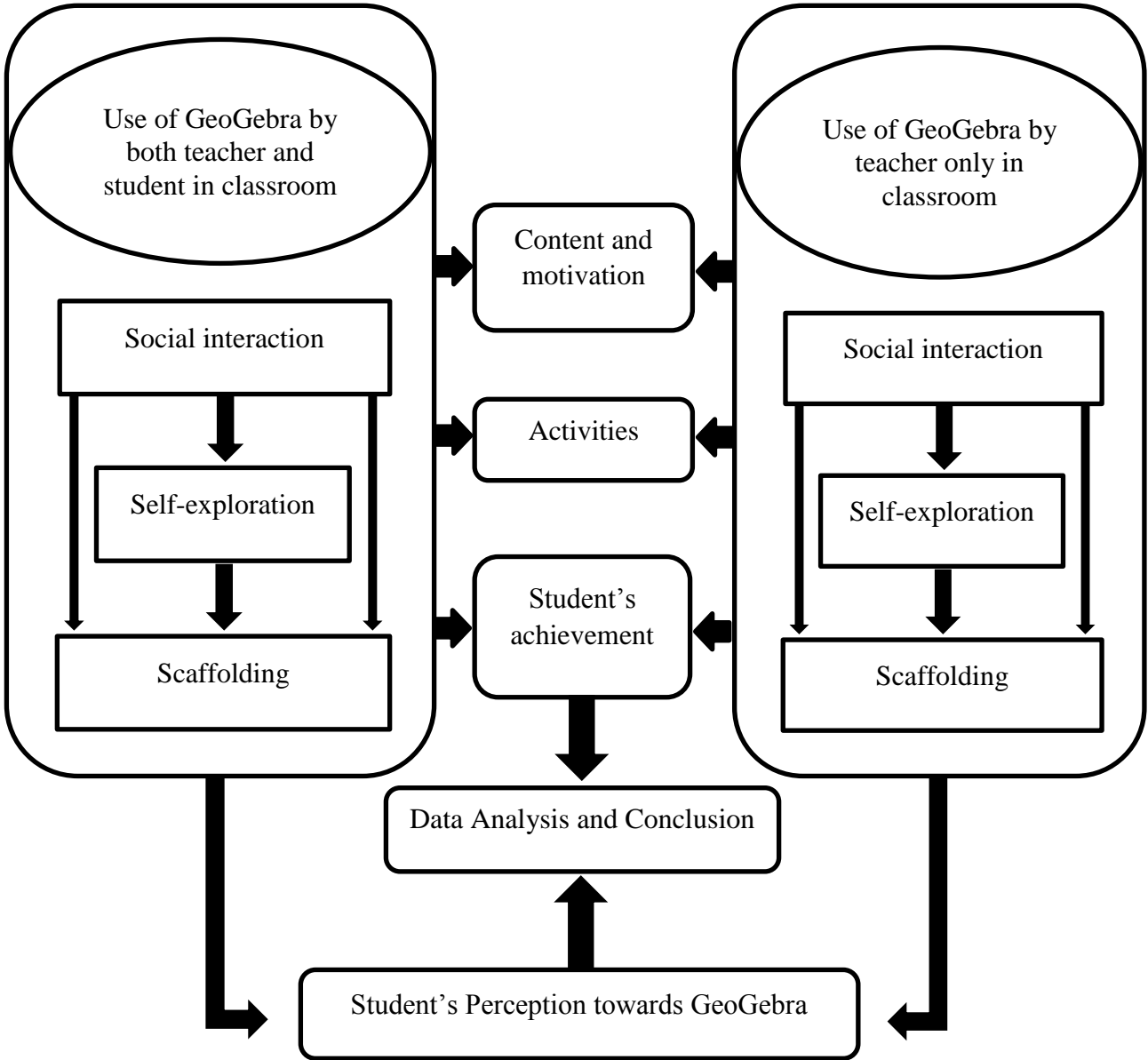
Vygotsky's view is closely related to the learning environment and emphasizes the theme that social interaction and the cultural environment contribute to the cognitive development of the child. Briefly, the whole study had followed the following framework. In this research, it was study about the effectiveness of using GeoGebra in teaching and learning geometry. The achievement test was taken and analyzed in both experimental and control groups. From both experimental group and control group were chosen for an interview to know how they felt in learning

geometry while using GeoGebra. And, also a set of questionnaires and semi-structure interview were used to know the students' perception toward GeoGebra.

In terms of input from both groups members. There higher ability students played a bigger role in helping the lower ability students to reach their ZPD. The higher ability students also benefit through the insights gain from their peers. GeoGebra gave the students an opportunity for peer interaction to enhance the understanding and visualization of the concept of circle and parallelogram. The major terminologies used in the conceptual framework are explained.

As indicated by above conceptual framework, for the both experimental group and control group, knowledge constructed from social interaction, self-exploration and scaffolding linking new knowledge to learner's existing knowledge.

The teacher started the class motivating the students towards the information they already had and the contents to be taught. Then, with the help of GeoGebra software, the teacher entered to the contents creating a proper environment to the social interaction and self-exploration. The teacher gave to construct the knowledge on the basis of interaction and self-exploration.

Chapter III

METHODS AND PROCEDURES

Research methodology and procedure is a guideline that helps to researcher to easily collect and analysis data. The following methodology and procedures were adopting to conduct the research for improvement of the study and full fill the objective of this research work. This chapter consist the research design, population sample and sampling procedure, data collection tools, reliability and validity of tools, data collection procedure and data analysis procedure.

Design of the Study

Research design is the plan, structure and strategy of investigation conceived so as to answer to research question and to control variance. Research design is the map or guideline of the research that provides the basic and fundamental way to conduct the research work successfully.

The main aim of this research was to investigate the effectiveness of GeoGebra, use by both teacher and students on teaching and learning geometry at grade IX. This research based on quasi-experimental design. Researcher selected experimental and control groups by coin tossed. Then the researcher adopted pre-test, post-test nonequivalent group design.

Where I participated in two groups namely experimental and control groups and compared their understanding and achievements. According to the hypothesis, the pre-test was taken to find the students' achievement before treatment and the post-test was taken after treatment to compare the achievement between these two groups. In addition, a set of questionnaires used to collect survey data as in both experimental and control groups to fulfill the second objective. And, also interview was taken for to collecting opinion of students' to fulfill second objective.

Table 3.1: Design of the study

Groups	Pre-test	Treatments	Post-test
Experimental	Q_1	Using GeoGebra by both teacher and students	Q_2
Control	Q_3	Using GeoGebra by teacher only	Q_4

Where,

Q_1=Pre-test given to experimental group

Q_2=Post-test given to experimental group

Q_3=Pre-test given to control group

Q_4=Post-test given to control group

Population, Sample and Sampling Strategy

Population. This study was conduct in Baglung district. So, all secondary level students, studied at grade IX on the academic year 2077 in Galkot municipality of Baglung was considered as population of the study.

Sample and Sampling Strategy. New Life Secondary Boarding School and Golden Future Secondary Boarding School were selected by the convenience sampling. In this study these both schools had well managed computer lab and other digital resources. From these two schools one selected as experimental group and another as the control group by coin toss. And computer laboratory having 20 computers and 3 projectors were available in New Life Secondary School. And also 15 computers and 2 projectors were available in Golden Future Secondary Boarding School. And both school administrators agreed to manage time and class for experiment.

Variables of the study

Variables are key ideas that researcher seek to collect information to address the purpose of their study. A concept which can take on different quantitative values

is called variables. Also, variable is a characteristic or attribute of an individual or an organization that researcher can measure or observe and varies among individual or organizations studied (Cresswell, 2012).

Different variables used in educational research. An independent variable is an attribute or characteristic that is dependent on or influenced by the independent variable (Cresswell, 2012). It means if one variable depended upon a consequence of the other variables, it is termed as dependent variables and the variable that antecedent to the dependent variable termed as an independent variable. Variables that are not related to the purpose of the study, but may affect the dependent variables are termed as extraneous variables. The variables in the study are classified as:

Independent variables. In this research, using GeoGebra by both teacher and students while teaching and learning geometry at Grade IX considered as independent variable.

Dependent variables. In this research, after teaching while using the GeoGebra by both teacher and students then we get the achievement known as dependent variable.

Extraneous variables. In this research, selection of the teaching material, school environment, teacher's attitudes in both groups, discipline of the students, teacher, subject matter, experimental time, students' labor, maturation of the students and home environment of the students were considered as extraneous variable.

Control Mechanism for Extraneous Variable

Many research conclusions of the experimental research were open to question due to the influence directly or indirectly of extraneous variable (Best & Kahn, 2006). The researcher minimized the effect of such variables as far as possible through research design or statistical procedures to increase the validity of the results.

In this study I was a researcher. There experimental group and control group were from same grade. I taught in both experimental and control groups with the help of same teaching method and materials on same duration of time and also same subject matters were taught in both groups. Same pre-test and post-test were administered for both groups on same day same time. Same point scoring system applied for scoring of answer sheet in both groups.

And, there was rejected all students who takes tuition and extra classes as well as whose parents' are able to teach mathematics. So, these all things helped us to minimize extraneous variable.

The Instrument for the Data Collection

For this research, the researcher used three instruments for the purpose of data collection. These were achievement tests (pre-achievement and post-achievement test), questionnaires and interview.

Achievement Test

Two achievement tests were prepared. They ware pre-test and post-test, for both achievement tests paper developed from topics of circle and parallelogram of grade IX. For pre-achievement test, this test consisted of 22 questions and there was 8 multiple questions of 1 mark for each, 6 very short questions of 1 mark for each, 4 short questions of 2 marks for each, 2 long questions of 4 marks for each and 2 very long questions of 5 marks for each. The post–achievement test was same number of questions with same marks as pre- achievement test. In other word it was the same structure as pre-achievement test question. But, that have slightly different questions from the pre-achievement test.

And there, pre-achievement test was used to measure the students' achievement before using GeoGebra software to teach. Post-achievement test used to measure the students' achievement after using GeoGebra-assisted instruction.

Oppionnaire

The opinionnaire /questionnaires used to analyze student's perception towards GeoGebra software in teaching and learning geometry. This study contained ten items of questionnaires based on five point Likert scale as 'Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree'. This questionnaires contained statements which reflect the students' perception about the use of GeoGebra software at grade IX. The reliability and validity of the questionnaires were verified by supervisor before testing student's perception towards GeoGebra software.

Interview Guidance

Interview is the process of communication in which the subject or interviewees gives the needed information verbally in face to face situation. So, researcher took an interview from both experimental and control groups to know the perception about use of GeoGebra to teach geometry at grade IX.

Item Analysis of the Test

The difficulty level and discrimination index of mathematics achievement test were computed to the quality of test items. Mainly difficulty index (P-value) and discrimination index (D-value) were computed to the standardized test items. The researcher conduct 34 questions of pilot test on the group of 19 students of Jalajala Shishu Sadan Secondary Boarding School from Dallu, Kathmandu. Then the researcher checked the answer sheets of each student. And P value of each item calculated from all students and D-value of each item calculated from tabulated upper 27% students and lower 27% students. The items analyzed and find that the difficulty level of P-value which lied between 40% to 100% and D-value of each item which value lied between the ranges 0.2 to 1 were chosen. And other item were rejected and modify.

Validity and Reliability of Tool

To make a significant contribution to the development of knowledge and good quality of test, must be valid which truly assessed the skill and abilities as indicated by the given learning outcomes. The validity of the achievement test, questionnaires and interview were established by the help of subject teacher, expert, and supervisor.

The pilot test was also conducted the reliability of each test item. The researcher conducted the pilot test students of Jalajala Shishu Sadan Secondary Boarding School of Dallu, Kathmandu. In this study, the split-half method was used to estimate the reliability of test items.

Experimental Stages

Experimental stages were categorized into three stages in this study, which as fallows;

Pre-experimental Stage. In the pre-experimental stage, the researcher developed the test item and questionnaires. The test item was related to the circle and parallelogram of grade IX. It included in both subjective and objective questions and the questionnaire related to Likert five point scales was based upon the student's view about the GeoGebra software and interview guideline. After developing the test item, mathematics achievement test were piloted on the group of students that are not included in sample for pre-test and post-test. Also analyzed the result of pilot test and selected the pre-test and post-test items of mathematics achievement test.

After selected pre-test item, pre-test was administered among the students of New Life Secondary Boarding School, Dudhila Bhati Secondary Boarding School, Golden Future Secondary Boarding School and Sambuddha Educational Academy Secondary Boarding School for the purpose of selection experimental and control groups through comparing their achievement. Among them, New Life Secondary

Boarding School selected as experimental and Golden Future Secondary Boarding School selected as control group.

After pre-test administrated and selection of these two groups. One of these school's students of the experimental group received GeoGebra training for 10 days (10 hours) class. All students of the group had basic computer literacy so it was very comfortable for researcher to train them basic knowledge (trained to use basic tools) of GeoGebra Software. There, in GeoGebra training session some students were very active and fast learner whom researcher picked and divide the whole class in 5 groups for each group had 4 students and all these fast learner of the each group helped their peers (who were slow learner) with the support of instructor. This helped to prepare them for experimental group.

Experimental Stage. In this stage, researcher himself taught the experimental and control groups regularly two weeks. Where, Students' of experimental group received instruction using GeoGebra by both teacher and students in the classroom. And, also students' of control group received instruction using GeoGebra but this software used by teacher only in the classroom.

Post-experimental Stage. In this stage, the post-test was administered among both groups. Also a set of questionnaire and interview were administered on both experimental and control groups. After collecting the students' answers and responses, the data were analyzed.

Data Collection Procedure

This study was mainly based on the quantitative data obtained from achievement test and a set of questionnaires. And qualitative data obtained from the semi-structure interview. Before started the class, the researcher met the principal and subject teacher and took permission for experimentation. After selecting the schools

then the researcher conducted the pre-test (achievement test) of Grade IX students in both experimental and control groups. The result of the pre-test analyzed quantitatively then I started the regular treatment of GeoGebra (used by both teacher and students) in the geometric lesson in the experimental group and gave the GeoGebra (used by teacher only) treatment for the control group. After 2 weeks quantitative, post-test (achievement) was administered within the same groups. After, that quantitative analysis of the result of post-test calculated. And also collected quantitative data by using questionnaires with Likert's method for students' perception about the GeoGebra in teaching geometry at grade IX. And I used semi-structure interview to collect the qualitative data from both groups to know students' perception about the GeoGebra in teaching geometry at grade IX.

Data Analysis and Interpretation Procedures

Data analysis and interpretation is important part of the study. After collecting data with the help of relevant tools and techniques, the next important step, is to analyze and interpret data with a view to arriving at empirical solution of problem (Singh, 2009). Quantitative data analysis was used to analyze the data gathered through the Achievement Test. The data obtained was analyzed using descriptive and inferential statistical analysis. In descriptive statistics, the mean and standard deviation computed for both experimental and the control groups. In inferential statistics, t-test was used to test for statistical significance difference between the control and experimental groups at the beginning of the study and at the end. Firstly, t-test conducted to determine whether the experimental and the control groups differ significantly in terms of their mathematics achievement level. Therefore, all pre-test scores of the experimental and the control groups were compared. Secondly, t-test conducted again to explore whether there is a statistically significant difference

between post-test scores of the control group and post-test scores of the experimental group after the treatment session ended. The hypothesis tested at the significance level of 0.05 since it is the mostly used value in educational studies.

And, a set of survey questionnaires were constructed to find the perception of students about use of GeoGebra at grade IX. Where, 5 point Likert's scale questionnaires was used. The collected data from questionnaires was analyzed by using mean and chi-square test.

Also, the semi-structured interview was used to find the perception of students about GeoGebra at grade IX. A researcher collected answers given by the students from interview. This qualitative data were analyzed by the descriptive and thematic code method.

Ethical Consideration

Ethical consideration is very important to be considered by researcher while collecting data and information. So, researcher considered information followed in my research:

- At first, researcher took a permission from schools administers, principal and subject teacher.

- The researcher build trust the respondent and respect the respondent's answers.

- Also researcher didn't culturally, ethically, socially biased while selecting the schools as my research sample.

Chapter-IV

ANALYSIS AND INTERPRETATION OF DATA

The most important part of the study is to analyze the collected data. The collected data in the form of large amount information has reduced into simplified form. This study entitled "Effectiveness of GeoGebra in teaching and learning geometry" was an experimental research design. The main aims of this study were to compare the achievement of students taught by using GeoGebra both by teacher and students versus GeoGebra used by teacher only. And to explore the student's perception about GeoGebra at grade IX.

This chapter deals with the statistical analysis and interpretation of data from the achievement score of the sample students. These data has tabulated and analyzed through mean, standard deviation and t-test. The students' perception taking from a set of questionnaire analyzed with the help of mean, chi-square test. Also, students' perception taking from interview analyzed with the help of descriptive and thematic code method. In this study, the research has analyzed under the following heading:

- Comparison of achievement score of students taught by using GeoGebra both by teacher and students versus GeoGebra used by teacher only in pre-test.

- Comparison of achievement score of students taught by using GeoGebra both by teacher and students versus GeoGebra used by teacher only in post-test.

- Comparison of the achievement scores of students on pre-test and post-test.

- Analyze the perception of the students about the GeoGebra in teaching geometry.

For the data collection procedure, researcher administered the achievement test in two schools (New Life Secondary Boarding School and Golden Future Secondary Boarding School of Galkot, Baglung). After testing the validity and

reliability of the test items, standardized questions were used in pre-test and post-test of the experimental and control groups of the study. For the data collection, pre-test, post-test non-equivalent quasi-experimental design was adopted for the purpose of the study. A pre-test was taken to make the groups comparable. Primarily, the achievement test of the students in post-test was taken to fulfill the first objective of the study. And to fulfill the second objective of the study; a set of questionnaires based on five point Likert's scale and interview were used. And these data were analyzed by using Microsoft Office Excel 2010 for arithmetic mean, percentage and chi-square value with based on five point Likert's scale. These all data were organized, tabulated, analyzed and interpreted as follows;

Comparison of Achievement of Students in Pre-test

In this section, researcher took the pre-test of experimental and control groups. Administered test items were used in this pre-test. The purpose of the pre-test was to compare the achievement scores between two groups. The pre-test score of student of experimental group and control group were of two ways. They were computation of mean and standard deviation of the marks obtained by using formula. The calculated mean, standard deviation and t-value on the pre-test result were shown in the following table;

Table 4.1: Comparison of students' achievement on pre-test

Group Type	Sample	Mean	S. D.	Calculated t-value	Decision
Experimental	20	17.3	8.09	0.03	There is no significant difference
Control	18	17.22	7.95		

The above table 4.1 shows us, there were 20 and 18 number of the students in experimental and control groups respectively. In pre-test 40 marks of mathematics achievement test was administrated. The mean of the experimental and control groups

ware 17.3 and 17.22 respectively. The mean score of experimental group was little higher than the control group. It represented average score of the students on the both groups were same.

Similarly, the standard deviation of experimental and control group were 8.09 and 7.95 respectively. Although, standard deviation of experimental and control groups were little difference but it indicated experimental and control groups were equal consistency in teaching and learning geometry.

Here, tabulated t-value at $\alpha = 0.05$ level of significance for two tailed test is 1.96 but calculated t-value was lying in critical region i.e. $-1.96 < 0.03 < 1.96$. So, Null hypothesis (H_0) is accepted and Alternative hypothesis (H_1) is rejected. Hence it could be conclude that there is no significance difference existed between the average score of experimental and control groups on pre-test. Therefore, the taught by using GeoGebra by both teacher and student group versus GeoGebra used by teacher only group were treated as homogeneous and same level of achievement in this study.

Figure 4.1 Mean and S.D scores distribution of pre-test result
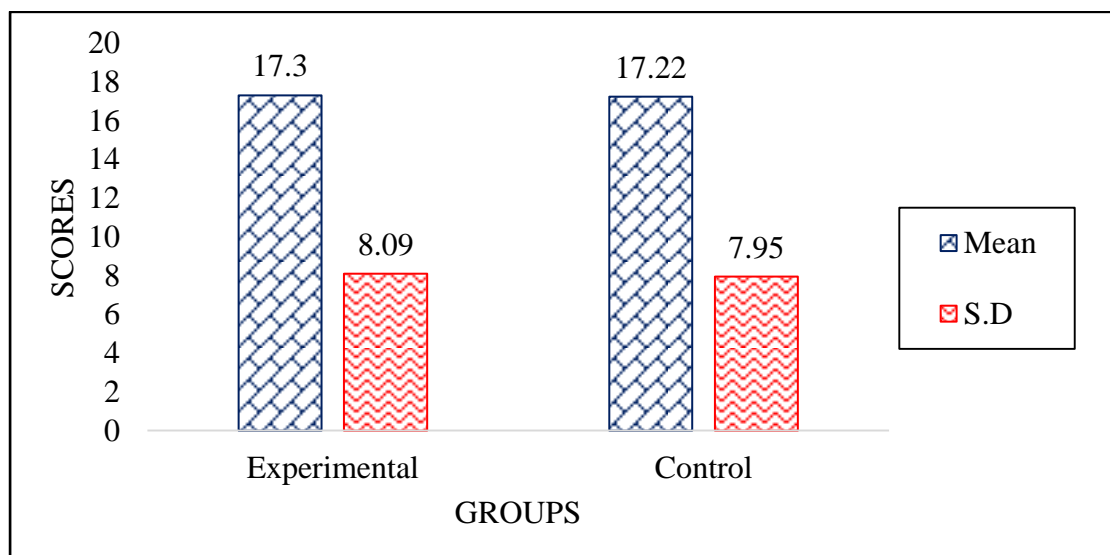
The mean and standard deviation scores obtained by the students of each group in the achievement test (pre-test) score have been shown in the above diagram

(figure 4.2). The column of experimental group of students is similar to the column control group students. This shows that there is no such difference in average achievement scores between experimental group and control group on pre-test result. Since the difference between the mean and standard deviation on the pre-test were 0.08 and 0.14 respectively. Therefore, these all data showed these two groups were homogeneous and same level of achievement in this study.

Comparison of Achievement of Students in Post-test

In this section, researcher took the post-test of experimental and control groups. After the completion of experimental phase, the post-test was taken. Which was slightly difference from administered pre-test items, used in post-test. The purpose of the post-test was to compare the achievement scores between two groups. The post-test score of students of experimental group and control group were of two ways. They were computation of mean and standard deviation of the marks obtained by using formula. The calculated mean, standard deviation and t-value on the post-test result were shown in the following table;

Table 4.2: Comparison of students' achievement on post-test

| Group Type	Sample	Mean	S. D.	Calculated t-value	Decision
Experimental	20	26.4	5.02	2.64	There is significant difference.
Control	18	21.72	5.89		

The above table 4.2 shows us, there were 20 and 18 number of the students in experimental group and control group respectively. In post-test 40 marks of mathematics achievement test was administrated. The mean of the experimental and control groups were 26.4 and 21.72 respectively. It shows that the mean score of experimental group was better than the control group. And also, it indicates, there was significant different between experimental group and control group on the post-test.

Thus, the taught by using GeoGebra by both teacher and students was more effective and higher achievement than GeoGebra used by teacher only.

Similarly, the standard deviation of experimental and control groups were 5.02 and 5.89 respectively. Here, standard deviation of the experimental group was less than the control group. So, the experimental group was better consistency than control group. It indicates taught by using GeoGebra by both teacher and students were more effective than GeoGebra used by teacher only.

Here, tabulated t-value at $\alpha = 0.05$ level of significance two tailed test is 1.96 but calculated t-value was not lying in critical region i.e. calculate value $2.64 > 1.96$. So, Null hypothesis (H_0) is rejected and Alternative hypothesis (H_1) is accepted. Hence it could be conclude that there is significance difference existed between the average score of experimental and control groups on post-test. Therefore, geometry taught by using GeoGebra by both teacher and students had better achievement than GeoGebra used by teacher only.

Figure 4.2 Mean and S.D scores distribution of post-test result
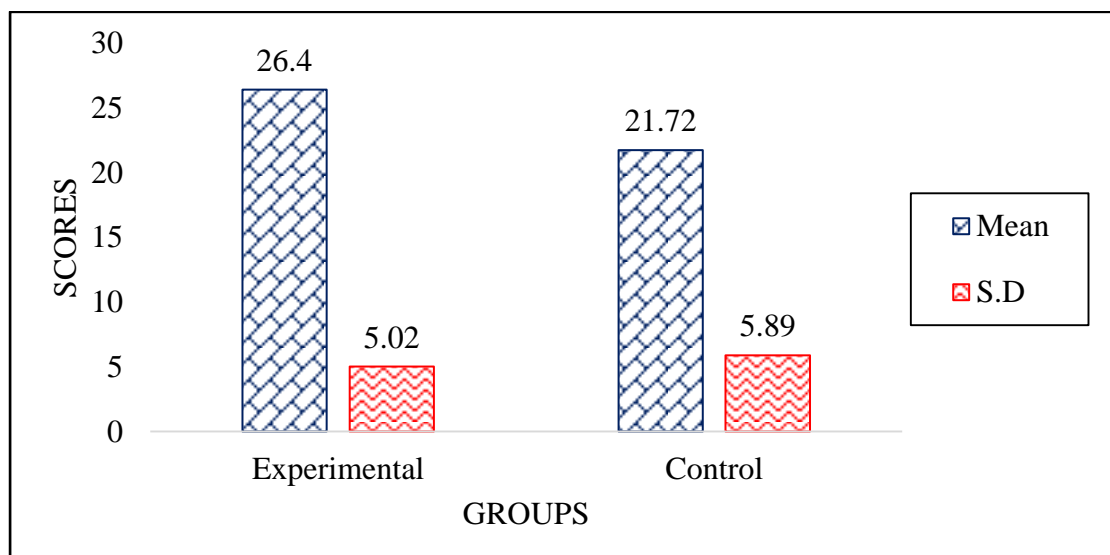
The mean and standard deviation scores obtained by the students of each group in the achievement test (post-test) score have been shown in the above diagram

(figure 4.2). The column of experimental group of students is longer than control group's students. This shows that there is a difference in average achievement scores between experimental and control group on post-test result. Since the difference between the mean and standard deviation on the post-test were 4.68 and 0.87 respectively. Therefore, the diagram (figure 4.2) indicates that, the achievement of students taught by using GeoGebra software both by teacher and student is better than GeoGebra used by teacher only on the chapters of circle and parallelogram of geometry at grade IX. This shows that the GeoGebra software using teacher and students helps to increase the achievement of students and it has better impact on students learning.

Comparison of Mean score on Pre-Test and Post-Test

The researcher comparison of the mean on pre-test and post-test of experimental and control groups as following presented in table 4.3.

Figure 4.3: Comparison of mean score of experimental and control groups of Pre-test and Post-test
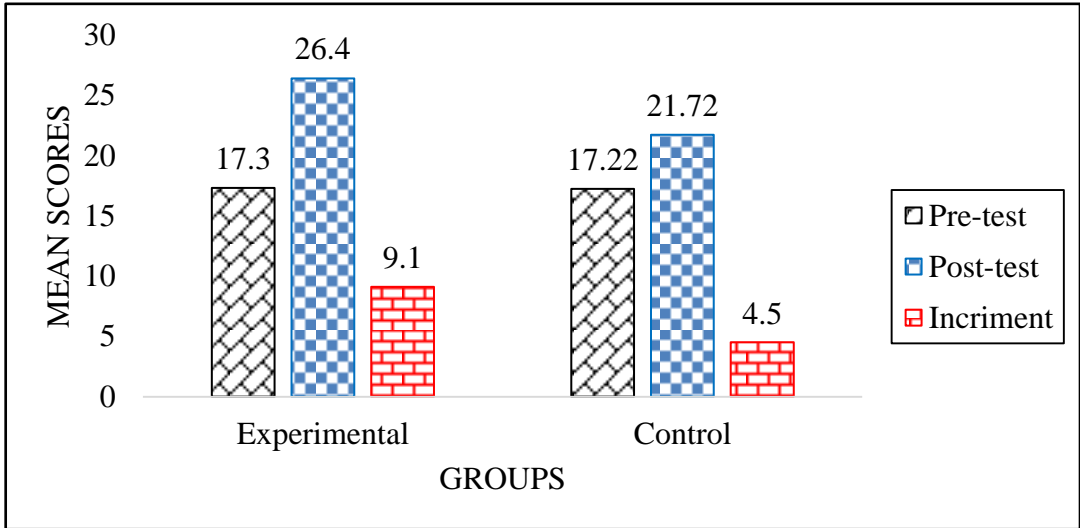
The above diagram (figure 4.3) shows that the mean score on pre-test of experimental and control groups were 17.3 and 17.22 respectively. But the mean

score on post-test of experimental group was 26.4 and control group was 21.72.

Which shows that 9.1 marks increment in mean score of experimental group but 4.5

marks increment in means score of control group. Therefore, mean score of

experimental group is highly increased than control group of students. It shows that,

the average score of experimental group was better than control group.

Comparison of Standard Deviation on Pre-test and Post-test

The researcher comparison of the standard deviation on pre-test and post-test

of experimental and control groups as following presented in table.

Figure 4.4: Comparison of Standard Deviation score of experimental and

control groups of pre-test and post-test
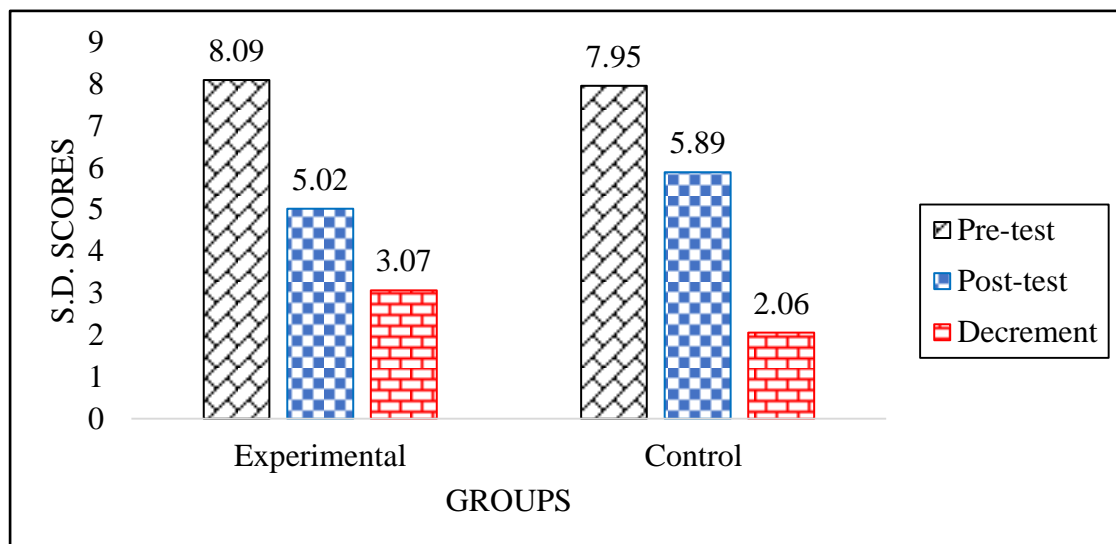
The above diagram (figure 4.4) shows that standard deviation on pre-test of

experimental and control group were 8.09 and 7.95 respectively. And the standard

deviation on post-test of experimental group was 5.02 and control group was 5.89.

Here, 3.07 decrement in standard deviation of experimental group and 2.06 decrement

in standard deviation of control group. The standard deviation of experimental group

was decreased more than standard deviation of control group. In the case of less

standard deviation, it was found high consistency. So, the researcher got less standard

deviation in experimental group of post-test. Thus, the researcher found high consistency in experimental group than control group. This shows that, geometry taught by usinig GeoGebra software by both teacher and students is more effective than GeoGebra used by teacher only in geometry at grade IX.

Analysis of Students' Perception about the GeoGebra

GeoGebra is dynamic software for teaching and learning mathematics. The researcher used GeoGebra software for 13 episode of teaching Geometry 'Circle and Parallelogram'. Students were very excited for learning and participated in classroom activities. So, to find out the perception of students about GeoGebra, the reseacher took oppionnaire and semi-structure interview from both experimental and control groups. Which are analyzed on the following topics;

- Analysis of students' perception from oppionaire
- Analysis of students' perception from interview

Analysis of Students' Perception from Oppionnaire

Researcher took an oppionnaire/questionnaire related to students view about GeoGebra software from both experimental and control groups. The quantitative data are provided in table 4.3 (in five point Likert's scale). Where, 5, 4, 3, 2 and 1 indicated strongly agree, agree, neutral, disagree and strongly disagree for positive statements and 1, 2, 3, 4 and 5 indicated strongly agree, agree, neutral, disagree and strongly disagree for negative statements.

Table 4.3: Result of students' perception on GeoGebra

Themes	S N	Items		Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Mean	Chi Square Value
Social interaction	1	GeoGebra helped to increase my questioning capacity to ask teacher and friends.	n. s.	17	16	2	3	0	38	4.24	35.42
			%	44.7	42.1	5.3	7.9	0	100		
	2	GeoGebra software made me very confident to express what I kwon about circle and parallelogram.	n. s.	17	15	6	0	0	38	4.28	34.37
			%	44.7	39.5	15.8	0	0	100		
	3	GeoGebra helped me to improve in geometry with the help of my existing knowledge.	n. s.	17	15	3	3	0	38	4.21	32
			%	44.7	39.5	7.9	7.9	0	100		
Self-exploration	4	I didn't like studying geometry lesson by using GeoGebra software.	n. s.	0	0	4	18	16	38	4.32	40.42
			%	0	0	10.5	47.4	42.1	100		
	5	I want to learn and use GeoGebra software myself.	n. s.	24	14	0	0	0	38	4.63	63.58
			%	63.2	36.8	0	0	0	100		
	6	I would like to learn more geometric concepts using GeoGebra.	n. s.	17	17	2	2	0	38	4.28	39.10
			%	44.7	44.7	5.3	5.3	0	100		
	7	I feel boring to learn by using GeoGebra software.	n. s.	0	0	4	5	29	38	4.65	78.05
			%	0	0	10.5	13.2	76.3	100		
Scaffolding	8	I can think creatively and critically when using GeoGebra software.	n. s.	18	13	6	1	0	38	4.26	31.73
			%	47.4	34.2	15.8	2.6	0	100		
	9	GeoGebra based teaching helps to learn easily about geometrical theorems and problems.	n. s.	12	22	4	0	0	38	4.21	46.73
			%	31.6	57.9	10.5	0	0	100		
	10	GeoGebra software helps to visualizing the problems related to geometrical concept.	n. s.	14	18	4	2	0	38	4.15	33.05
			%	36.8	47.4	10.5	5.3	0	100		
Overall mean = 4.32											

The above table 4.3 shows that, the highest mean 4.65 was on the item 'I feel boring to learn by using GeoGebra software' and the lowest mean was 4.15, which is obtained on the item 'GeoGebra software helps to visualizing the problems related to geometrical concept'. Other item's mean were near about the average mean (overall mean) 4.32.

According to Denbel (2015) and Shadaan & Kwaneu (2013), a mean score of 3.0 or higher indicates a positive feedback or view about GeoGebra and the mean score lower than 3.0 indicates negative feedback or view about GeoGebra in learning geometry. The result from overall mean 4.32 and all statements of calculated Chi-square values were greater than the table values at 0.05 level of significance with 4 degree of freedom. This shows that students have positive responses or view about the GeoGebra software and the result was significant on each statement.

Figure 4.5: Percentage of students view on GeoGebra
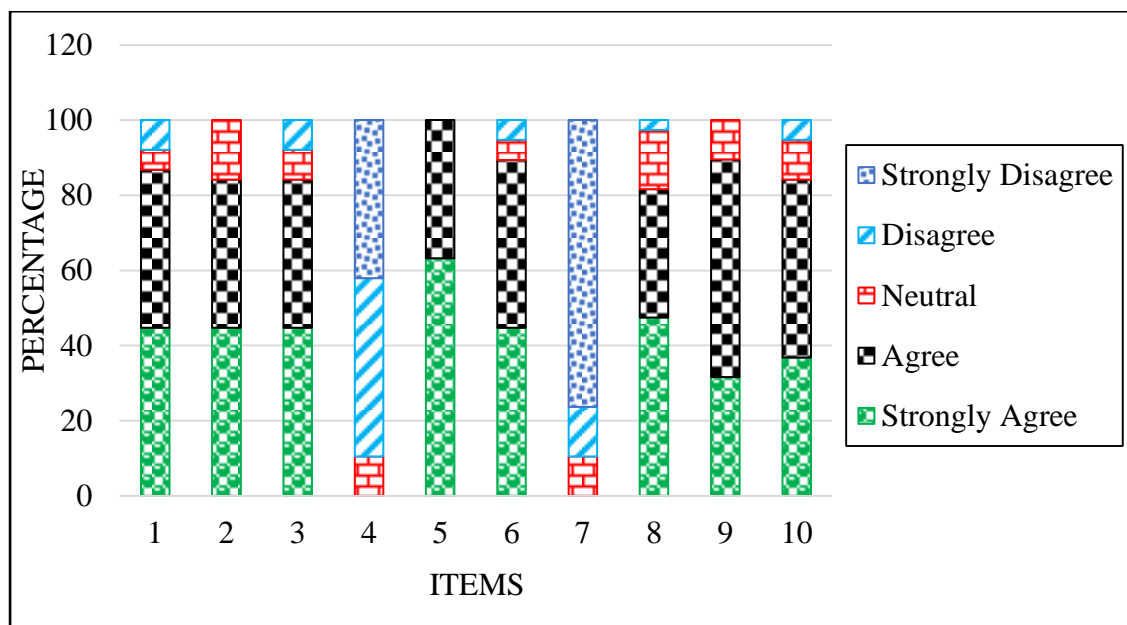
From above table 4.3 and figure 4.5, we have ten items of the questionnaire were categorized in to three section such as Social interaction, Self-exploration and Scaffolding which are described below;

Social Interaction. When GeoGebra used in the classroom, students were involving and interacting with solving the geometrical problems on the basis of their existing knowledge linking with new knowledge along with their friends and as well as a teacher. In this section, three items of questionnaire were included which are describe as follows.

Table 4.3.1: Result of students' perception on GeoGebra

S N	Items		Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Mean	Chi Square Value
1	GeoGebra helped to increase my questioning capacity to ask teacher and friends.	n. s.	17	16	2	3	0	38	4.24	35.42
		%	44.7	42.1	5.3	7.9	0	100		
			86.8							
2	GeoGebra software made me very confident to express what I kwon about circle and parallelogram.	n. s.	17	15	6	0	0	38	4.28	34.37
		%	44.7	39.5	15.8	0	0	100		
			84.2							
3	GeoGebra helped me to improve in geometry with the help of my existing knowledge.	n. s.	17	15	3	3	0	38	4.21	32
		%	44.7	39.5	7.9	7.9	0	100		
			84.2							

From the above table 4.3.1, the first statement, 'GeoGebra helped to increase my questioning capacity to ask teacher and friends' has Chi-square value 35.42 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.24 less than the average mean. 86.8% students agreed with this statement.

This shows that most of the students got improve there thinking level and so they were liked to more questioning to their teacher and friends which helped them to progress in geometry.

Similarly, the second statement 'GeoGebra software made me very confident to express what I kwon about circle and parallelogram' has Chi-square value 34.37 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.28 which is close to the average value. 84.2% of students agreed with this statement. This shows that, students got clear concept about circle and parallelogram by using GeoGebra, so they were felt that they can do.

Likewise, the third statement 'GeoGebra helped me to improve in geometry with the help of my existing knowledge' has Chi-square value 32 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.21 which is close to the average value. 84.2% of students agreed with this statement. Thus, result of this statement shows that they were felt easy to learn geometry by using GeoGebra connecting with their existing knowledge with new knowledge.

These all statements' results show that most of the students liked GeoGebra software and they were interested to learn geometry by using GeoGebra software including discussion with their peers and teacher. They had improved theire geometrical thinking and so they were satisfying from GeoGebra software.

Self-exploration. In this section four items of questionnaire were included to know their realization about GeoGebra or what they think, is used of GeoGebra software valueable for them or not? These four items are described as below.

Table 4.3.2: Result of students' perception on GeoGebra

S N	Items		Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Mean	Chi Square Value
1	I didn't like studying geometry lesson by using GeoGebra software.	n. s.	0	0	4	18	16	38	4.32	40.42
		%	0	0	10.5	47.4	42.1	100		
						89.5				
2	I want to learn and use GeoGebra software myself.	n. s.	24	14	0	0	0	38	4.63	63.58
		%	63.2	36.8	0	0	0	100		
			100							
3	I would like to learn more geometric concepts using GeoGebra.	n. s.	17	17	2	2	0	38	4.28	39.10
		%	44.7	44.7	5.3	5.3	0	100		
			89.4							
4	I feel boring to learn by using GeoGebra software.	n. s.	0	0	4	5	29	38	4.65	78.05
		%	0	0	10.5	13.2	76.3	100		
						89.5				

From the above table 4.3.2, the first statement 'I didn't like studying geometry lesson by using GeoGebra software' has Chi-square value 40.42 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.32 which is equal to the average value. 89.5% of students disagreed with this statement. This shows that most of the students liked GeoGebra software and they were interested to learn geometry with GeoGebra software. They want to solve geometrical problems by using GeoGebra software.

Similarly, the second statement 'I want to learn and use GeoGebra software myself' has Chi-square value 63.58 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom.

The mean response of students was found 4.63 which is greater than the average value. 100% of students agreed with this statement. This shows that most of the students liked GeoGebra software and they were interested to learn geometry with GeoGebra software. They are very interested to learn GeoGebra Software and use it.

In the same way, the third statement 'I would like to learn more geometric concepts using GeoGebra' has Chi-square value 39.1 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.28 which is close to the average value. 89.4% of students agreed with this statement. This shows that most of the students liked to use GeoGebra software at mathematical class. It helps them to make easy to understand problem as well as concept of circle and parallelogram.

Likewise, the fourth statement, 'I feel boring to learn by using GeoGebra software' has Chi-square value 78.05 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.65 which is greater than the average value. 89.5% of students disagreed with this statement. This shows that it helped them to make easy geometric problem and made active them, so most of the students liked GeoGebra software and they were interested to learn geometry with the help of GeoGebra software.

Scaffolding. Each and every student were encouraged to participate actively and given opportunity to progress faster. Weak students were given better attention together with the opportunity to progress at a slower pace. Thus, from the all process GeoGebra helped to them progress in geometry. So, in this section three items were included which are described as follows.

Table 4.3.3: Result of students' perception on GeoGebra

SN	Items		Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Mean	Chi Square Value
1	I can think creatively and critically when using GeoGebra software.	n. s.	18	13	6	1	0	38	4.26	31.73
		%	47.4	34.2	15.8	2.6	0	100		
			81.6							
2	GeoGebra based teaching helps to learn easily about geometrical theorems and problems.	n. s.	12	22	4	0	0	38	4.21	46.73
		%	31.6	57.9	10.5	0	0	100		
			89.5							
3	GeoGebra software helps to visualizing the problems related to geometrical concept.	n. s.	14	18	4	2	0	38	4.15	33.05
		%	36.8	47.4	10.5	5.3	0	100		
			82.2							

From the above table 4.3.3, the first statement, 'I can think creatively and critically when using GeoGebra software' has Chi-square value 31.73 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.26 which is close to average value. 81.6% of students agreed with this statement. It means that the students are positive and they could think creatively and critically when using GeoGebra software. This shows that most of the students liked GeoGebra software and they were interested to learn geometry with GeoGebra software.

Similarly, the second statement, 'GeoGebra based teaching helps to learn easily about geometrical theorems and problems' has Chi-square value 46.73 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found

4.21 which is less than the average value. 89.5% of students agreed with this statement. This shows that all of the students liked GeoGebra software and they were interested to learn geometry with the help of GeoGebra software. It means they were easily understood the geometrical theorems and problems by using GeoGebra software.

Likewise, the third statement, 'GeoGebra software helps to visualizing the problems related to geometrical concept' has Chi-square value 33.05 which is greater than the tabulated value of 9.488. So the statement is significant at 0.05 level of significance with 4 degree of freedom. The mean response of students was found 4.15 which is less than average value. 82.2% of students agreed with this statement. It means GeoGebra software was helpful to visualize mathematical problem related to geometrical concepts and it increased the active participation of mathematical classroom and also promotes the geometric knowledge.This shows that most of the students liked GeoGebra software and they were interested to learn geometry by using GeoGebra software

Therefore, most of the students gave the positive responses about the above items and felt easy to understand the geometrical concepts as well as problems and theorems. They were happy and interesting to take the geometrical class where GeoGebra software as a toll for learning. Also, it helped to improve the students' number in class participation, activities. So, GeoGebra is very essential and important software for teaching and learning geometrical concepts, problems and theorems.

Analysis of Students' Perception from Interview

Researcher took an interview related to students view about GeoGebra software from both experimental and control groups. Among 38 students, researcher selected 8 students from both groups where 4 students form experimental group and 4

students from control group. Among 4 students form experimental group, 2 (boy and girl) students had higher score than average achievement score and 2 (boy and girl) students had lower score than average achievement score on post-test. Also, from control group, among 4 students, 2 (boy and girl) students had higher score than average achievement score and 2 (boy and girl) students had lower score than average achievement score on post-test. Now, the perception of students presented by the sample students were discussion on the following heading;

GoeGebra as a Process of Social Interaction. The theory of constructivism, knowledge is not taught but is learn by the learner themselves through constructing new knowledge on the base of old knowledge, under certain settings, with the help of teacher or study partner and learning while the teacher works as an organizer, facilitator, and motivator, utilizing setting, cooperation, and dialogue to motivate student's activity and creativity (Liu, 2010). Furthermore, the researcher had asked the student: "Did you join the group discussion with your classmate and teacher when you had any confusion with geometric problem?"
The students answered:

"Yes, off course, we joined in group discussion for our confusion. And we got the help from our friends and also we support to each other to solve problem of circle and parallelogram. And also if we had any problem we asked our teacher and got help from him."

In the above mentioned response shows that they were discussing with the group of their peers and their teacher. They liked to learn from interaction with friends on a specific topic. They feel easy in learning through interaction using GeoGebra software.

The social interaction plays a fundamental role in the development of cognition. Vygotsky (1978) states "Every function in the child cultural appears twice, first between people and then inside the child logical memory and formation of concepts. All the higher function originates as actual relationships between individuals."

The second aspect of Vygostky's theory is the idea that the potential for cognitive development depends upon the "zone of proximal development (ZPD). A level of development attention when students engage in social behavior. The full development of ZPD depends on open full social interaction. The range of skills that can be developed with adult guidance or peer collaboration exceeds what can be attained alone, in social interaction higher level of students play a big role in helping the lower ability students to reach their ZPD. The higher-level student also benefits through the new idea and views of their peers.

GeoGebra as a Motivator for Self-exploration of Geometry Learning. Motivate is defined as a desire for knowledge which is a central part of curiosity. When GeoGebra used in class, students were involving and interacting with solving the mathematical problem with their friends and as well as a teacher. The researcher asked students, "What extent did you think GeoGebra has aroused your curiosity?" The student answered:

"Certainly, GeoGebra had reconstructed our basic idea, concept, and knowledge related to constructed figure better which motivated us to solve the geometrical problem and their application in the proving theorem. Moreover, we would like to learn more geometric concepts through GeoGebra because the dynamic platform of GeoGebra was very interesting for better understanding to extend of our self-learning."

These views regards GeoGebra has motivating tools for better understanding and sustainable knowledge for the student. They were motivated to solve the problem and proving related theorem also. The use of GeoGebra helped the student to reconstruct their existing knowledge and enforce them to engage in inquiry-based activities. Cohen et al. (2013) describe that constructivism learning theory searches for meaning, looking for the whole as well a part of considering curiosity and inquiry as important principles. GeoGebra has become a motivational force and important motivational tool for geometrical learning (Eu and Shadaan, 2013)

GeoGebra as a Scaffolding Tool for Geometry. Scaffolding provides special type of help that assists learners move towards new concepts, skills, or understandings. In this study we got GeoGebra is the best scaffolding tool in developing school's level students' geometrical thinking. So, the researcher asked students, "In what way do you think the GeoGebra software helped you in your learning process?"

The student answered:

"GeoGebra helped to imagine how the subject matter actually is and actually what is. It helped us to visualize geometrical concept which makes to solve problem easily. Furthermore, we learnt mathematics by practice but now we learnt mathematics by understanding. We can memories circles and parallelogram's related problems and theorems for long time without looking the book and copies"

From the above mentioned responses shows that use of GeoGebra software as a necessary tool for teaching geometry. It helps to students visualize the mathematical subject matter and helps to imagine new concept of that subject matter. Not only, it helps to them think deeply about mathematical problem, also, they can solve easily. This shows that they are interested to learn geometry with the help of GeoGebra.

Positive perceptions towards GeoGebra in teaching geometry. After all this topic added here. After teaching through the help of GeoGebra for both groups. There were many changes in students' behavior, such as; interest in doing homework, classroom participation, involving the submission of classwork, interesting with friends as well as teacher. While the question asking in the interview, "Give your views and suggestions for use of GeoGebra in teaching mathematics."
The student answered:

"We liked GeoGebra software for teaching mathematics. It made us very clear concept about circle and parallelogram related theorems and problems. We hope we'll do better in coming examination. We feel it would be better, if we could learn always by using GeoGebra in teaching mathematics".

So, researcher found that, students were happy in learning with GeoGebra. Students can understand the geometry by using the visual materials. It all shows that use of GeoGebra software has positive effects for teaching and learning geometry.

Based on the finding, this suggested that GeoGebra was very helpful for teaching and learning Geometry. And the development of technology tools GeoGebra increase the student's achievement in their learning geometry. The above result shows that, in teaching and learning geometry, use of GeoGebra software was more effective.

Chapter V

SUMMARY, FINDING, CONCLUSION AND RECOMEDETION

After analysis and interpretation of the data, this chapter deals with summary of the researcher work with findings, conclusions and recommendations.

Summary of the Study

The research entitled "Effectiveness of GeoGebra in teaching and learning geometry" was intended to investigate the using GeoGebra software by both teacher and students was more effective than GeoGebra software used by teacher only and also analyzed the student's perception toward GeoGebra software in teaching geometry at grade IX.

For the data collection of the study, the researcher developed and tested the reliability of achievement test and also find the difficult level (P %) and the discrimination index (D) of items before their administration. The test was consisted of 12 multiple choice questions, 8 very short questions, 6 short questions, 4 long questions and 4 very long questions from circle and parallelogram of geometry of grade IX.

The pre-test and post-test design of quasi-experimental was adopted for the purpose of the study. Students of grade IX of Galkot municipality of Baglung District have been considered as population. The sample of schools were selected through the convenience method of sampling were New Life Secondary Boarding School, Dudhila Bhati Secondary Boarding School, Golden Future Secondary Boarding School, Sambuddha Educational Academy Secondary Boarding School in Galkot, Baglung. Among them, New Life Secondary Boarding School selected as experimental group with 20 students and Golden Future Secondary Boarding School selected as control group with 18 students.

After teaching 2 weeks in New Life Secondary Boarding School by using GeoGebra software by both teacher and students. And, also teaching same days in Golden Future Secondary Boarding School taught by using GeoGebra software by teacher only. Then researcher collected data of students' achievement from the both groups by using mathematics achievement test and students' perception on GeoGebra software by using 5 point Likert's scale questionnaires and interview.

Two hypothesis were analyzed from the result of pre-test (show in table 4.1) and post-test (show in table 4.2). The score obtained by the students on pre-test was analyzed using t-test at 0.05 level of significance, mean and standard deviation which shows that there is no significant difference the average achievement score of two groups. And the score obtained by post-test was also analyze using t-test at 0.05 level of significance, mean and standard deviation which shows that average achievement score and consistency of experimental group was better than control group.

In this study geometry teaching using GeoGebra software by both teacher and students is more effective than teaching by using GeoGebra software by teacher only at grade IX. The result highlighted that students in the experimental group performed better using GeoGebra by both teacher and students than the control group that used GeoGebra by teacher only in the classroom. In addition, students view toward GeoGebra was analyzed through the questionnaire and interview. These questionnaire and interview questions were distributed to both experimental and control groups and result shows that students have positive perception toward GeoGebra software in teaching geometry at grade IX. The result shows that GeoGebra makes geometry class interesting and enjoyable. Students were interesting and curious to learn the geometry through the GeoGebra.

Finding of the Study

From the result of the Experimental study, the researcher had the finding. Researcher selected the two non-equivalent groups as the experimental group and control group.

Accepting or rejecting the significance of null hypothesis constructed for the study determined the effectiveness of GeoGebra software which used by teacher and students in classroom as compared to use GeoGebra software by teacher only in classroom and questionnaire and interview constructed for the analyzing students' view towards GeoGebra software in teaching geometry at grade IX. The findings of this study were observed from the calculated and tabulated t-value recorded in table for hypothesis to achieve the objectives of the study. Also mean and Chi-square value for students' view toward GeoGebra software for teaching geometry. After the analysis of data the major findings of this study were listed below;

- There was no significant difference between the average achievement score of experimental and control groups on pre-test. The mean and standard deviation of the experimental and control groups were 17.3 and 8.09, 17.22 and 7.95 gradually and t-test was 0.03.

- There was significant difference between the average achievement score of these groups on post-test. The mean and standard deviation of the experimental and control groups were 26.4 and 5.02, 21.72 and 5.89 gradually t-test was 2.64.

- The teaching using GeoGebra software by both teacher and students was more effective than GeoGebra software used by teacher only in teaching and learning geometry.

- The result shows that students gave positive feedback or view toward the GeoGebra software in teaching geometry.

- The result shows that GeoGebra makes geometry class interesting and enjoyable.

Conclusions

The research is one of the very difficult work. If the design, sample and tools were not selected suitably. Perhaps, the research would be completely failure. The researcher must be selected design, sample and tools for the study. In this study, sample represented whole students of Galkot municipality of Baglung District of grade IX.

GeoGebra, mathematics software has been proven as very strong tool to teach and learn geometry at grade IX. Therefore, the use of GeoGebra software has been proven as one of the best strategy in teaching geometry for better understanding and learning for performance permanence in the context of Nepal. The use of GeoGebra software by both teacher and students surely increase student's scores than the use of GeoGebra software by teacher only. The use of GeoGebra software in mathematics seems as if it provides an ample opportunity to each individual for developing creativity curiosity by active participation.

In addition, the use of GeoGebra provides the opportunities for interaction between students-students and teacher-students during the learning and thus students are provided ample opportunities of learning through social interaction there by supporting the constructivists' view of learning. Therefore use of GeoGebra in the geometry lesson is essential for teaching geometry for better understanding and for fruitful learning. The result shows that, students gave positive feedback or view toward the GeoGebra software in teaching geometry.

Recommendation

The recommendation suggestion or proposal as to the best course of action, especially one put forward by an authoritative body. This study had only focused the identification of the effectiveness of GeoGebra used by both teacher and students in teaching geometry in term of the students' achievement and perception based of the quasi experimental design taking only a few sample for the purposive of the researcher. Others researcher may carry out a study with in large sample for in order to identify the effectiveness of GeoGebra in mathematics lessons at various levels as well. Based on the research, the following recommendation were provided for the educational and further study:

Recommendations for educational implication. The use of GeoGebra in teaching and learning geometry helps to inspire the students for the learning and improve the scores in mathematics. So it has much educational implication in the education field as well as ICT based learning. The major educational implications of the research are follows;

- It could be used as the supportive materials for teacher and students.

- GeoGebra software can be used as the pedagogy of teaching.

- Teachers, students, researchers, educationist study this research and they can design the teaching method by using GeoGebra.

- It can be used for the educational policy maker.

- This research can be usable for CDC of school level.

- This researcher can be used for software developer.

- This research can be useful to facilitate ICT in school level in Nepal

Recommendation for the further study. This study was limited to the effectiveness of GeoGebra in teaching and learning Geometry only. It focused on

student's achievement in topic of 'Circle and Parallelogram' of geometry at grade IX. It was done in small sample size. There are many areas remaining for research related to GeoGebra. Based on this research, researcher has following recommendation for the further study;

- It is recommended that to do the similar study on other level of the school.

- This study was limited to Galkot municipality of Baglung district. So, similar study be done in others district.

- This kind of study should be conducted at all level of school and others subjects as well.

- It is recommended to find the effectiveness of GoeGebra in the Ruler area of the Nepal.

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APPENDICES

Appendix-A

Subjective and Objective Questions for Pilot Test

Class: IX   Full Marks: 68

Subject: C. Mathematics   Time: 2 hrs. 05 min

****

All questions are compulsory

Multiple Choice Questions (Tick the best (√) answer):   **[12× 1=12 marks]**

1. What is the angle subtended by the diameter of a semi-circle?

    a) 45°   b) 60°

    c) 90°   d) 180°

2. Which of the following is the longest chord of a circle?

    a) Semi-circle   b) Radius

    c) Chord   d) Diameter

3. From the following figure. What is the name of shaded part OPQ?

    a) arc   b) sector

    c) segment   d) secant

4. In the adjoining figure ,O is the centre of circle and AB is its chord .If AP = PB,

    which of the following is the relation between OP and AB?

    a) OP ∥ AB   b) OP = AB
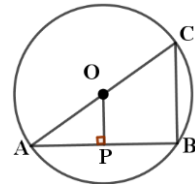
    c) OP = 2AB   d) OP ⊥ AB

5. In the given figure AB=CD, which of the following is the relation between OP

    and OQ?

    a) OP ∥ OQ   b) OP = OQ

    c) OP ⊥ OQ   d) OP = $\frac{1}{2}$ OQ

6. If AB and CD are two chords of a circle intersecting at point E, what is the relation between ∠BEQ and ∠CEQ? As per the given figure.

a) ∠BEQ ≠ ∠CEQ

b) ∠BEQ = ∠CEQ

c) ∠BEQ < ∠CEQ

d) ∠BEQ > ∠CEQ

7. Which one of the following characteristics of Parallelogram based on sides?

a) All sides are equal.

b) Opposite sides are equal.

c) Opposite sides are parallel.

d) Opposite sides are equal and parallel.

8. In a quadrilateral WXYZ, which angles should be equal to be a parallelogram?

a) ∠W = ∠X & ∠W = ∠Y

b) ∠X = ∠Y

c) ∠W = ∠Y & ∠X = ∠Z

d) ∠Y = ∠Z

9. Which of the following statements is not correct?

a) Parallelogram is subset of quadrilateral.

b) Parallelograms has opposite angles are equal.

c) Every quadrilaterals are parallelograms.

d) Every parallelograms are quadrilateral.

10. In a parallelogram MNOP, ∠N= (2x+10) ° and ∠P=120°. What is the value of x?

a) 60°

b) 110°

c) 120°

d) 55°

11. In the given figure, A, B, C and D are the mid-points of sides of parallelogram PQRS. If area of PQRS=36 cm², then which of the following is true for area of ABCD?

a) 18 cm²

b) 20 cm²

c) 24 cm²

d) 26 cm²

12. The sum of two opposite angles of a parallelogram is 140°.What are the angle of

the parallelogram?

  a) 65°, 115°   b) 70°, 110°

  c) 80°, 100°   d) 75°, 105°

Very Short Question   **[8 × 1= 8 marks]**

1. Define circle.

2. From the following circle, what is the name

   of line segment PQ

3. If a line PQ intersects two concentric circles at the points

   A, B, C and D as shown in the figure, write the relation

   between AB and CD.

4. In the figure given alongside: O is the centre of circle.

   If OQ ⊥ CD, OP ⊥ AB and OQ = OP, Write the relation

   between the chord AB and CD.

5. Define Parallelogram.

6. In a parallelogram, the base and height are 6 cm and 5 cm respectively. What is its

   area?

7. Write the properties of rhombus.

8. In the given parallelogram ABCD, AB+CD = 20 cm.

   What is the length of CD?

Short Question   **[6 × 2 = 12 marks]**

9. In the given figure O is the centre of a circle. If OC⊥MN,

   OC=5cm and MN=24cm, find the length of diameter of circle.

10. In the adjoining figure, O is the centre of a circle with

radius 5 cm and AB = 8 cm. If OP⊥AB, find the length of BC.

11. In the given figure, O is the centre of circle ABCD. IF OY ⊥ PB,

OX ⊥ PC, OX = OY, AB = 6 cm and AP = 2 cm, find the length

of PC.
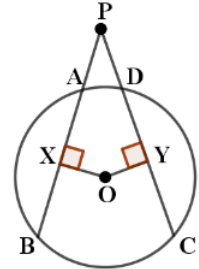
12. In the given figure, ABCD is a parallelogram.

∠ABC = 120° and DA = DE. Find the size of ∠AED.
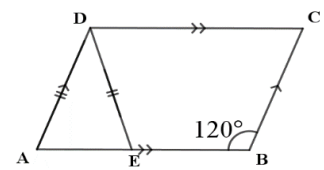
13. In the given parallelogram ABCD, if ∠B = (2x+25) °

and ∠D = (4x-15) °. What is the angle of ∠BAD?
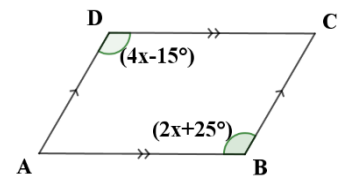
14. In the adjoining figure, calculate the size of

unknown angles.
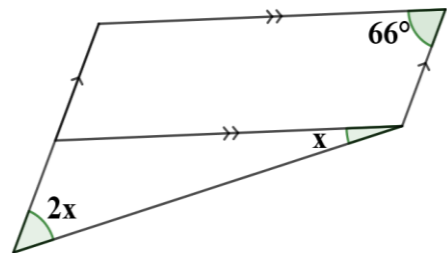
Long Question **[4 × 4 = 16 marks]**

15. Prove that the perpendicular drawn from the centre of a circle to a chord, bisect

the chord.

16. In the given figure, O is the centre of the circle. Two equal chords

AB and CD intersect at E. Prove that OE is the bisector of ∠BED.
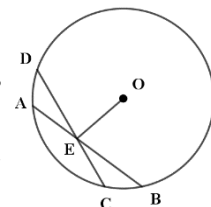
17. P and Q are the mid-points of the diagonals BD and AC

respectively of a quadrilateral ABCD. If M and N are the

mid-points of the sides DC and AB respectively, prove

that PMQN is a parallelogram.
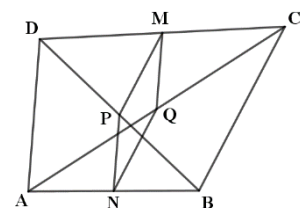
18. Prove that the diagonals of a parallelogram bisect to each other.

Very Long Question   **[4 × 5 = 20 marks]**

19. In the given figure, P and Q be the centres of two

    intersecting circles and AB // PQ. Prove that AB = 2PQ.
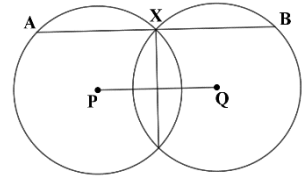
20. In the adjoining figure AB and CD are two chords of a circle

    such that AB= 8 cm, CD = 15 cm and AB⫽CD. If the distance

    between AB and CD is 5 cm, find the radius of the circle.
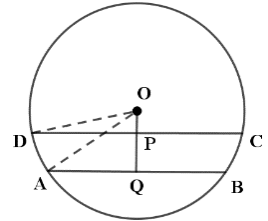
21. ABCD is a parallelogram. DE ⊥ AC and BF ⊥ AC.

    Prove that BEDF is parallelogram.
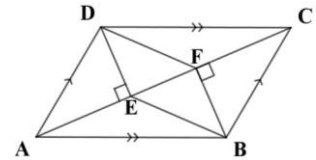
22. Let L, M, P and Q be the mid points of four sides

    AB, BC, CD and DA of Quadrilateral ABCD respectively.

    Prove that LMPQ is a parallelogram.
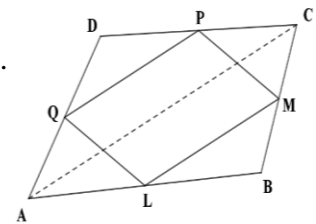
Appendix-B

Mathematical Achievement Test Prepared for Pre-test

Class: IX   Full Marks: 40

Subject: C. Mathematics   Time: 1 hr.15 min

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All questions are compulsory

Multiple Choice Questions (Tick the best (√) answer):   **[8× 1=8 marks]**

1. Which of the following is the longest chord of a circle?

   a) Semi-circle   b) Radius

   c) Chord   d) Diameter

2. From the following figure. What is the name of shaded part OPQ?

   a) arc   b) sector

   c) segment   d) secant
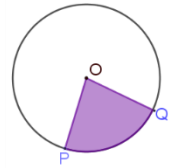
3. In the adjoining figure ,O is the centre of circle and AB is its chord .If AP = PB,

   which of the following is the relation between OP and AB?

   a) $OP /\!/ AB$ b) $OP = AB$

   c) $OP = 2AB$ d) $OP \perp AB$
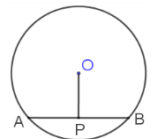
4. In the given figure AB=CD, which of the following is the relation between OP

   and OQ?

   a) $OP /\!/ OQ$ b) $OP = OQ$

   c) $OP \perp OQ$ d) $OP = \frac{1}{2} OQ$
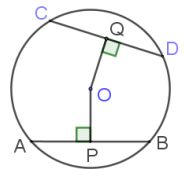
5. Which one of the following characteristics of Parallelogram based on sides?

   a) All sides are equal.   b) Opposite sides are equal.

   c) Opposite sides are parallel. d) Opposite sides are equal and parallel.

6. In a quadrilateral WXYZ, which angles should be equal to be a parallelogram?

   a) ∠W = ∠X & ∠W = ∠Y   b) ∠X = ∠Y
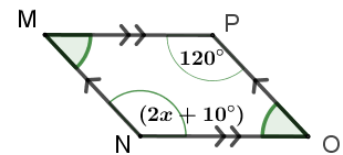
   c) ∠W = ∠Y & ∠X = ∠Z   d) ∠Y = ∠Z
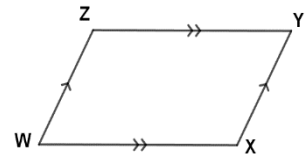
7. Which of the following statements is not correct?

   a) Parallelogram is subset of quadrilateral.

   b) Parallelograms has opposite angles are equal.

   c) Every quadrilaterals are parallelograms.

   d) Every parallelograms are quadrilateral.

8. In a parallelogram MNOP, ∠N= (2x+10) ° and ∠P=120°. What is the value of x?

   a) 60°   b) 110°

   c) 120°   d) 55°

Very Short Question   **[6 × 1= 6 marks]**

9. Define circle.

10. From the following circle, what is the name

    of line segment PQ
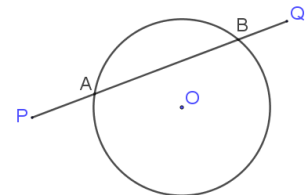
11. In the figure given alongside: O is the centre of circle.

    If OQ ⊥ CD, OP ⊥ AB and OQ = OP, Write the relation
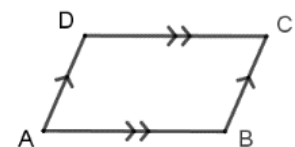
    between the chord AB and CD.
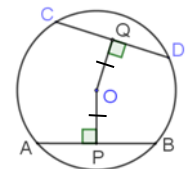
12. Define Parallelogram.

13. In a parallelogram, the base and height are 6 cm and 5 cm respectively. What is its

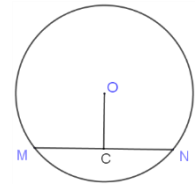   area?

14. In the given parallelogram ABCD, AB+CD = 20 cm.

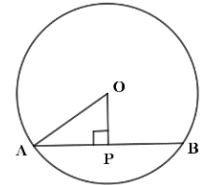   What is the length of CD?

Short Question [4 × 2 = 8 marks]

15. In the given figure O is the centre of a circle. If OC⊥MN,

    OC=5cm and MN=24cm, find the length of diameter of circle.
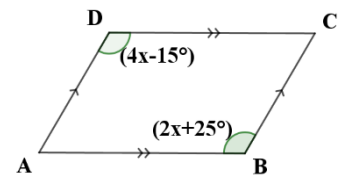
16. In the adjoining figure, O is the centre of a circle with

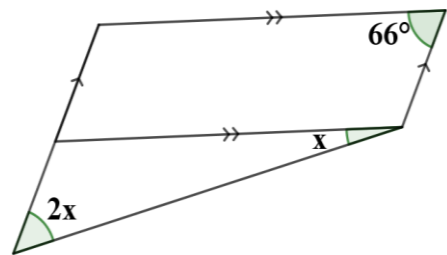   radius 5 cm and OP = 3 cm, find the length of the chord.

17. In the given parallelogram ABCD, if ∠B = (2x+25) °

    and ∠D = (4x-15) °. What is the angle of ∠BAD?

18. In the adjoining figure, calculate the size of

    unknown angles.

Long Question [2 × 4 = 8 marks]

19. Prove that the perpendicular drawn from the centre of a circle to a chord, bisect

    the chord.

20. Prove that the diagonals of a parallelogram bisect to each other.

Very Long Question [2 × 5 = 10 marks]

21. In the adjoining figure AB and CD are two chords of a circle

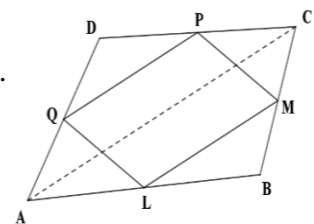   such that AB= 8 cm, CD = 15 cm and AB ∥ CD. If the distance

    between AB and CD is 5 cm, find the radius of the circle.
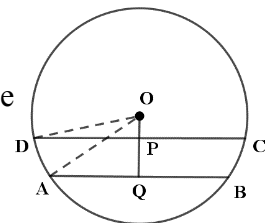
22. Let L, M, P and Q be the mid points of four sides

    AB, BC, CD and DA of Quadrilateral ABCD respectively.

    Prove that LMPQ is a parallelogram.

Appendix-C

Mathematical Achievement Test Prepared for Post-test

Class: IX   Full Marks: 40

Subject: C. Mathematics   Time: 1 hr.15 min

****

All questions are compulsory.

Multiple Choice Questions (Tick the best (√) answer):   **[8× 1=8 marks]**

1. If a line segment that passes through the centre of circle and joins any two points

    on its circumference then what is it called?

    a) Semi-circle   b) Radius
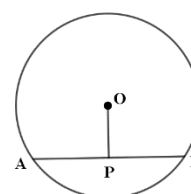
    c) Chord   d) Diameter

2.   In the adjoining figure of circle, if O is the centre then

    what is the name of shaded part?

    a) arc   b) sector

    c) segment   d) secant
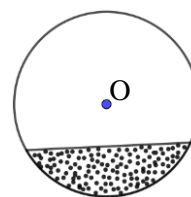
3. In the adjoining figure ,O is the centre of circle and AB is its chord .If OP ⊥ AB,

    which of the following is the relation between AP and PB?

    a) AP ∥ PB   b) AP ⊥ PB

    c) AP = 2PB   d) AP = PB

4. In the figure given alongside: O is the centre of circle.

     If OQ ⊥ CD, OP ⊥ AB and OQ = OP, which of the following is

     the relation between the chord AB and CD.

    a) AB ∥ CD   b) AB = CD

    c) AB ⊥ CD   d) $AB = \frac{1}{2} CD$
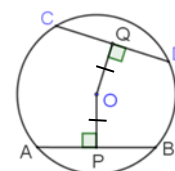
5. Which one of the following is not special types of parallelograms?

   a) quadrilateral   b) rectangle

   c) square   d) rhombus

6. Three angles of a parallelogram are 75°, 90° and 75°. What is the fourth angle?

   a) 90°   b) 95°

   c) 105°   d) 120°

7. Which of the following statements is not correct?

   a) The opposite angles and sides of a parallelogram are equal.

   b) The diagonals of a parallelogram bisect each other.

   c) If the opposite angles of a quadrilateral are not equal, the quadrilateral is a

   parallelogram.

   d) If the opposite sides of a quadrilateral are equal, the quadrilateral is a

   parallelogram.

8. In the given figure, PQRS is a parallelogram in which ∠PSR = 125°,

   Which of the following is equal to ∠RQT?

   a) 125°   b) 55°

   c) 65°   d) 75°
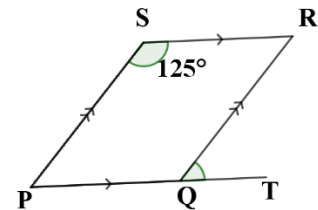
Very Short Question   **[6 × 1= 6 marks]**

9. Write the definition of semi-circle.

10. In the adjoining figure of circle. If MN is the tangent,

    what is the name of point P?

11. If the radius of circle is 3.5 cm find its perimeter.

12. Three angles of a quadrilateral ABCD are equal. Is it a parallelogram?

13. Write the definition of parallelogram.
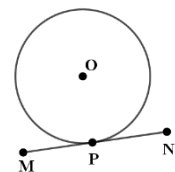
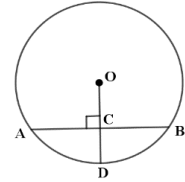14. In the given parallelogram WXYZ, YZ = 10 cm.

What is the length of WX+YZ?
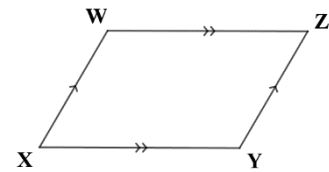
Short Question [4 × 2 = 8 marks]

15. In the given circle, O is the centre and OC ⊥ AB.

If AB = 16 cm and OD =10 cm then find the length of CD.

16. In the given figure, O is the centre of a circle. If PX = QX,

PQ = 24 cm and AB = 26 cm, find the length of OX.
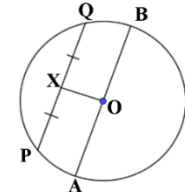
17. ABCD is a parallelogram, in which ∠BAD = 60° and

∠CBD = 70°. Find the measure of ∠BDC.
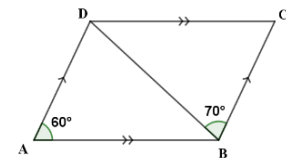
18. In the given figure, ABCD is a parallelogram.

∠ABC = 120° and DA = DE. Find the size of ∠AED.
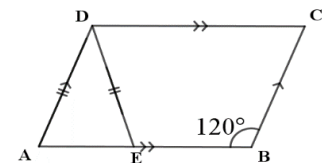
Long Question [2 × 4 = 8 marks]

19. Prove that equal chords of a circle are equidistant from the centre.

20. Prove that the straight line segments that join the ends of two equal and parallel

line segments towards the opposite sides bisect each other.

Very Long Question [2 × 5 = 10 marks]

21. In the adjoining figure AB and CD are two chords of a

circle such that AB = 6 cm, CD = 12 cm and AB \\ CD.

If the distance between AB and CD is 3 cm, find the

radius of the circle.
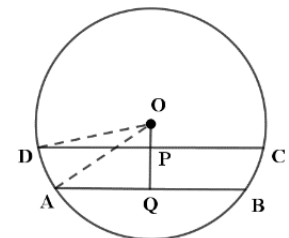
22. In the given figure, ABCD is a quadrilateral in which

diagonals AC and BD bisect each other at O. Prove

that ABCD is a parallelogram.

Appendix-D

Student's Perception towards GeoGebra Software in Teaching and Learning

Geometry

Name: ……………………………   Roll No: ……………………

Class: Nine   Subject: Comp. Mathematics

School: ………………………………………………………………………

Dear students,

Read each items carefully and tick (√) on your choice option.

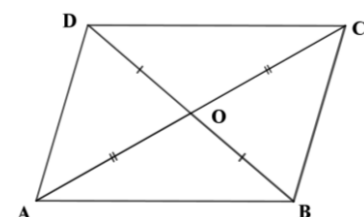| S.N	Items	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
1	GeoGebra helped to increase my questioning capacity to ask teacher and friends.					
2	GeoGebra software made me very confident to express what I kwon about circle and parallelogram.					
3	GeoGebra helped me to improve in geometry with the help of my existing knowledge.					
4	I didn't like studying geometry lesson by using GeoGebra software.					
5	I want to learn and use GeoGebra software myself.					
6	I would like to learn more geometric concepts using GeoGebra.					
7	I feel boring to learn by using GeoGebra software.					
8	I can think creatively and critically when using GeoGebra software.					
9	GeoGebra based teaching helps to learn easily about geometrical theorems and problems.					
10	GeoGebra software helps to visualizing the problems related to geometrical concept.					

Appendix-E

Interview Guideline

1. Did you join the group discussion with your classmate and teacher when you had any confusion with geometric problem?

2. What extent did you think GeoGebra has aroused your curiosity?

3. In what way do you think the GeoGebra software helped you in your learning process?

4. Give your views and suggestions for use of GeoGebra in teaching geometry.

Appendix-F

Teaching Episode-1

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Circle

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   - Define circle.

   - Introduce circumference, radius, diameter, semi-circle, arc, chord, and semi-circle.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - How can we draw a circle?

   - How can you define circle?

Stage-II: Approach to the first objective.

   Activity-II: Discussion on the following questions with the use of GeoGebra.

   - Observe the dynamic figure and make your own definition of circle.
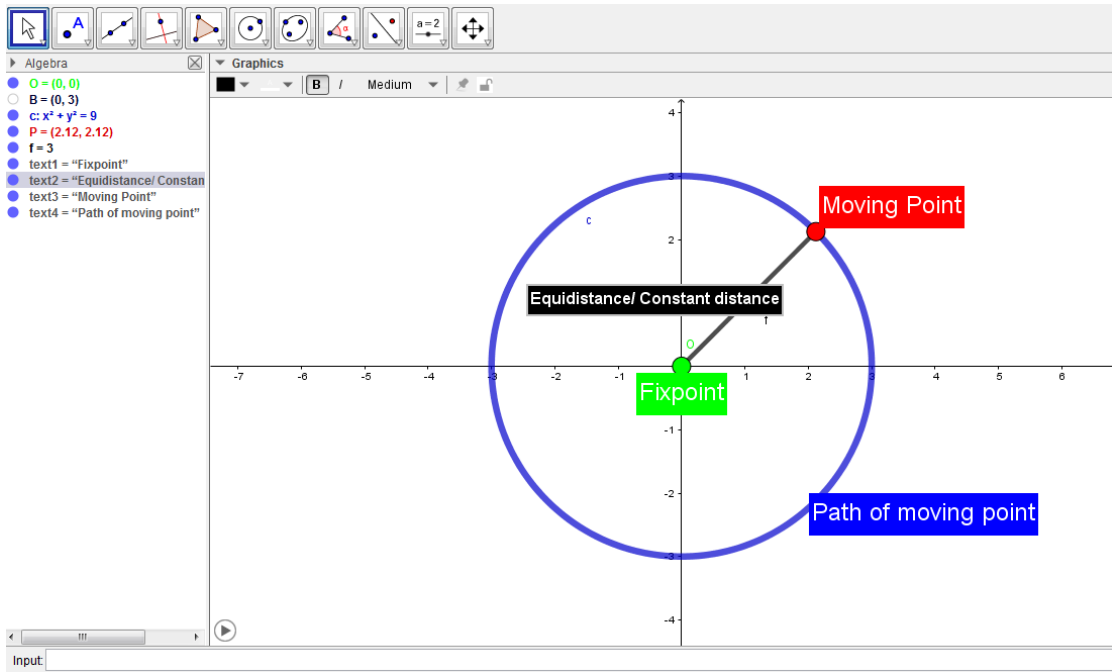
Definition of Circle.

Circle is the locus of points which is the equidistance from a fix point.

Stage-III: Approach to the second objective.

Activity-III: Discussion on the following questions with the use of GeoGebra.

- What are: circumference, radius, diameter, semi-circle, arc, chord, and

   semi-circle?

Teaching Episode-2

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Circle

----

1. **Specific Objectives**

On the completion of this lesson, the students will be able to

i.   Introduce segment of circle, sector of circle, concentric circles, intersecting

        circles, tangent to a circles, and secant of a circle.

2. **Activities**

Stage-I: Warm up and review

Activity-I: Discussion on the following questions with the use of GeoGebra.

- Say about following terms of circle: centre, circumference, radius,

    chord, diameter and arc.

Stage-II: Approach to the objective.

Activity-II: Discussion on the following questions with the use of GeoGebra.

- What are segment of circle, sector of circle, concentric circles,

    intersecting circles, tangent to a circles, and secant of a circle?

Teaching Episode-3

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Circle

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   i.   Prove that the perpendicular drawn from the centre of a circle to a chord
           bisects the chord.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - Make the right angle triangle and name the sides with hypotenuse, base
     and perpendicular.

   - What are centre, radius and chord of circle?

   - What is the meaning of bisect?

   - What are the axioms to show the two triangles congruent?

   - Which axiom will be used if two right angles triangles to show
     congruent?

Stage-II: Approach to the first objective.

   Activity-II: Discussion on the following questions with the use of GeoGebra.

   - Prove that the perpendicular drawn from the centre of a circle to a
     chord bisects the chord.

Theorem:-17

The parpendiclar drawn from the centre of a circle to a chord, bisect the chord.

Theoretical proof

Given: O is the centre of a circle. AB is the chord of
the circle and OP ⊥ AB.
To prove: AP=PB
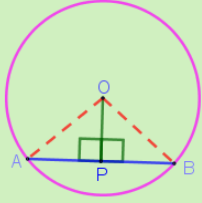
Construction: O,A and O,B are joined.

Proof
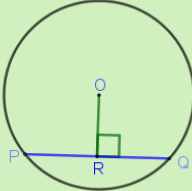
Statement	Reason
1.In rt.∠ed Δ OAP and OBP	1
i.∠OPA = OPB(R)	i.Both of them are right angles
ii.OA = OB(H)	ii.Radii of same circle.
iii.OP = OP(S)	iii.Common side
2.ΔOAP ≅ ΔOBP	2.R.H.S axiom
3.AP = PB	3.Corresponding sides of congruent triangle

Proved

Reset   Next

Now Its your turn:

Prove that the parpendiclar drawn from the centre of a circle to a chord, bisect the chord.

- The radius of a circle is 10 cm and the length of a chord of the circle is 12 cm. Find ther distance of the chord from the centre of the circle.

Teaching Episode-4

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Circle

----

1. Specific Objectives

On the completion of this lesson, the students will be able to

i.   Prove that the line joining the mid-point of a chord and the centre of a

circle is perpendicular to the chord.

2. Activities

Stage-I: Warm up and review

Activity-I: Discussion on the following questions with the use of GeoGebra.

- What is mid-point in the line segment?

- What will be happened if we perpendicular drawn from centre of

circle to a chord.

Stage-II: Approach to the objective.

Activity-II: Discussion on the following questions with the use of GeoGebra.

- Prove that the perpendicular drawn from the centre of a circle to a

chord bisects the chord.

Converse of Theorem-17

The line joining the mid-point of a chord and the centre of a circle is perpendicular to the chord.

Theoretical proof

Given: O is the centre of a circle and AB is the chord. P is the mid-pont of AB. O and P are joined.
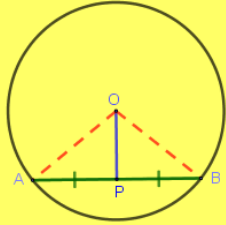
To prove: OP ⊥ AB

Construction: O,A and O,B are joined.

Proof
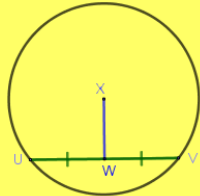
Statement	Reason
1. In rt.∠ed Δ OAP and OBP	1.
(i)OA = OB(S)	(i) Radii of the same circle.
(ii)AP = PB(S)	(ii) Given(P is the mid point of AB)
(iii)OP = OP(S)	(iii) Common side
2. ΔOAP ≅ ΔOBP	2. S..S.S axiom
3.∠OPA = ∠OPB	3. Correspondig angles of congruent triangle.
4.∠OPA = ∠OPB = 90⁰	4.Adjacent angles in linear pair are equal.
5. OP□AB	5. Froom the statement 3.

Proved

Now it's your turn:

Prove that the line joining the mid-point of a chord and the centre of a circle is perpendicular to the chord.

Teaching Episode-5

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Circle

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   i.   Prove that equal chords of a circle are equidistant from the centre.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - What is chord?

   - Which is the longest chord of circle?

   - Draw the two equal chords on a circle.

   - What is meaning of equidistance?

Stage-II: Approach to the first objective.

Prove that equal chords of a circle are equidistant from the centre.

<u>**Teaching Episode-6**</u>

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Circle

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   1.   Prove that chords are equidistant from the centre of a circle are equal.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - If two chords are equal, what will be the relation about distance from

     the centre of circle to these chords?

   - What will be converse statement of "equal chords of a circle are

     equidistant from the centre".

Stage-II: Approach to the objective.

   Activity-II: Discussion on the following questions with the use of GeoGebra.

   - Prove that chords are equidistant from the centre of a circle are equal.

Converse of theorem:18

Chords which are equidistant from the centre of a circle are equal.

Theoretical proof

Given: O is the centre of a circle. AB and CD are two chords
of the circle.and OP ⊥ AB, OQ ⊥ CD and OP=OQ.
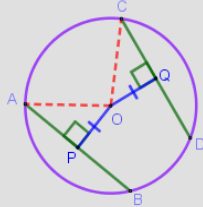
To prove: AB=CD

Construction: O,A and O,C are joined.

Proof

Statement	Reason
1. In rt∠ed ΔOAP and ΔOCQ	1.
(i)∠OPA = ∠OQC(R)	(i) Both of them are right angles
(ii)OA = OC(H)	(ii) Radii of the same circle.
(iii)OP = OQ(S)	(iii) Given.
2. ΔOAP ≅ ΔOCQ	2. R.H.S axiom
3.AP = CQ	3. Corresponding sides of congruent triangles.
4.2AB = 2CD, i.e.AB = CD	4.OP ⊥ AB and OP bisects AB;OQ ⊥ CD and OQ bisects CD.
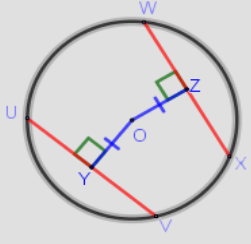
Proved

Reset   Next

Now, it's your turn:

Chords which are equidistant from the centre of a circle are equal.

<u>**Teaching Episode-7**</u>

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   i.   Introduce parallelogram and special types of parallelogram such as

          rectangle, square and rhombus.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - What is rectangle?

   - What is square?

   - What is rhombus?

Stage-II: Approach to the first objective.

   Activity-II: Discussion on the following questions with the use of GeoGebra.

   - What do you know about parallelogram?

   - What is parallelogram?

Stage-III: Approach to the second objective.

Activity-III: Discussion on the following questions with the use of GeoGebra.

- What are special types of parallelogram?

- What are the property of rectangle, square and rhombus which satisfy them all are special types of parallelogram?

Now it's your turn:

- What is parallelogram?

- What are the special type of parallelogram?

Teaching Episode-8

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

----

1. Specific Objectives

On the completion of this lesson, the students will be able to

  i.   To prove the straight line segments that join the ends of two equal and

       parallel line segments towards the same sides are also equal and parallel.

2. Activities

Stage-I: Warm up and review

  Activity-I: Discussion on the following questions with the use of GeoGebra

- What is parallelogram?

- What are the special type of parallelogram?

- What do you know about S.A.S axiom?

- What is alternative angles?

Stage-II: Approach to the first objective.

  Activity-II: Discussion on the following questions with the use of GeoGebra.

- Prove the straight line segments that join the ends of two equal and parallel

  line segments towards the same sides are also equal and parallel.

Now, it's your turn:

- If PQ = RS and PX // RS. The ends P, R and X, S are joined, Write the relations between PR and XS.

- Prove that the straight line segments that join the ends of two equal and parallel line segments towards the same sides are also equal and parallel.

Teaching Episode-9

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

----

1. Specific Objectives

On the completion of this lesson, the students will be able to

i. Prove that the straight line segments that join the ends of two equal and parallel line segments towards the opposite sides bisect each other.

2. Activities

Stage-I: Warm up and review

Activity-I: Discussion on the following questions with the use of GeoGebra.

- What is the statement of yesterday class?

- What is the meaning of bisect.

- What will be happened if the straight line segments that join the ends of two equal and parallel line segments towards the opposite sides.

Stage-II: Approach to the first objective.

Activity-I: Discussion on the following questions with the use of GeoGebra.

- Prove that the straight line segments that join the ends of two equal and parallel line segments towards the opposite sides bisect each other.

Theorem 14:

The straight line segments that join the ends of two equal and parallel line segments towards the opposite sides bisect each other.

Given: AB = CD and AB // CD. the opposite ends A, D
and B, C are joined. Let, AD and BC intersect at O.

To prove: AD and BC bisect each other at O.
i.e. AO = OD and BO = OC

Proof:

	Statements		Reasons
1	$In \Delta ABC and \Delta COD$	1	
(i)	$\angle ABO = \angle OCD(A)$	(i)	AB // CD and alternate angles
(ii)	$AB = CD$ (S)	(ii)	Given
(iii)	$\angle BAO = \angle ODC(A)$	(iii)	AB // CD and alternate angles
(iv)	$\therefore \Delta AOB \cong \Delta COD$	(iv)	A.S.A. axiom
2	$AO = OD and BO = OC$	2	Corresponding sides of congruent triangles
3	AD and BC bisect each other at O.	4	From statement (2)

Proved.   NEXT   RESET

Now, it's your turn:

- In the given figure. If AB = CD, AB // CD and
  AD = 12 cm, BC = 10 cm then find the length
  of AO and BO.

- In the given figure, if WX = YZ and WX // YZ
  and W, Z and X, Y are joined. So, WZ and XY
  are intersect at O. Then prove that WZ and XY
  bisect each other.
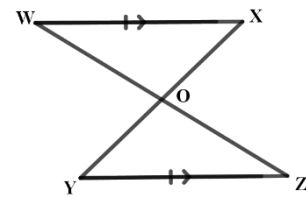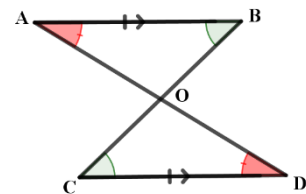
Teaching Episode-10

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   i. To prove that the opposite angles and sides of a parallelogram are equal.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - What are characteristics of parallelogram?

   - What is the statement of theorem which yesterday we learnt?

   - Do you know opposite angles of parallelogram are equal.

Stage-I: Approach to the first objective.

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - Prove that the opposite angles and sides of a parallelogram are equal.

Theorem 15:

The opposite angles and sides of a parallelogram are equal.

Given: ABCD is a parallelogram in which AB // DC and AD // BC.

To prove: (i) $\angle ABC = \angle ADC$, $\angle BAD = \angle BCD$

(ii) $AB = DC$, $AD = BC$

Construction: Diagonal AC is drawn.

Proof:

	Statements		Reasons
1	In $\triangle ABC$ and $\triangle ACD$	1	
(i)	$\angle BAC = \angle ACD (A)$	(i)	AB // DC and alternate angles
(ii)	$AC = AC$ (S)	(ii)	Common side
(iii)	$\angle ACB = \angle CAD (A)$	(iii)	AD // BC and alternate angles
(iv)	$\therefore \triangle ABC \cong \triangle ACD$	(iv)	A.S.A. axiom
2	$\angle ABC = \angle ADC$	2	Corresponding sides of congruent triangles
3	$\angle BAD = \angle BCD$	3	Drawing the diagonal BD and same as above in $\triangle ABD$ and $\triangle BCD$
4	$AB = DC$ and $AD = BC$	4	Corresponding sides of congruent triangles

Proved.

Now, it's your turn:

- In a parallelogram MNOP, ∠N= (2x+10) ° and ∠P=120°. What is the value of x?
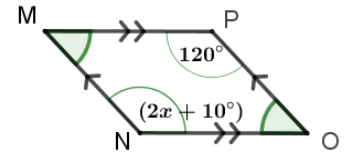
- In the given parallelogram ABCD, AB+CD = 20 cm. What is the length of CD?
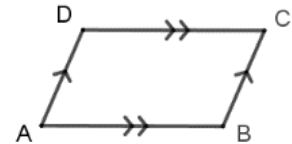
- Prove that the opposite angles and sides of a parallelogram are equal.

<u>Teaching Episode-11</u>

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

----

1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   i. To prove that if the opposite sides of a quadrilateral are equal, the quadrilateral

      is a parallelogram.

2. **Activities**

Stage-I: Warm up and review

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - What is about the of yesterday class?

   - What will be the converse statement of "the opposite angles and sides

     of a parallelogram are equal."?

   - What will be happened a quadrilateral? if the opposite sides of the

     quadrilateral are equal.

Stage-II: Approach to the first objective.

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - Prove that if the opposite sides of a quadrilateral are equal, the

     quadrilateral is a parallelogram.

Now, it's your turn:

- If PQRS is a quadrilateral in which PQ = RS and PX = QR, prove that

  PQRS is a parallelogram.

Teaching Episode-12

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

----

1. Specific Objectives

On the completion of this lesson, the students will be able to

i. To prove that the diagonals of a parallelogram bisect each other.

2. Activities

Stage-I: Warm up and review
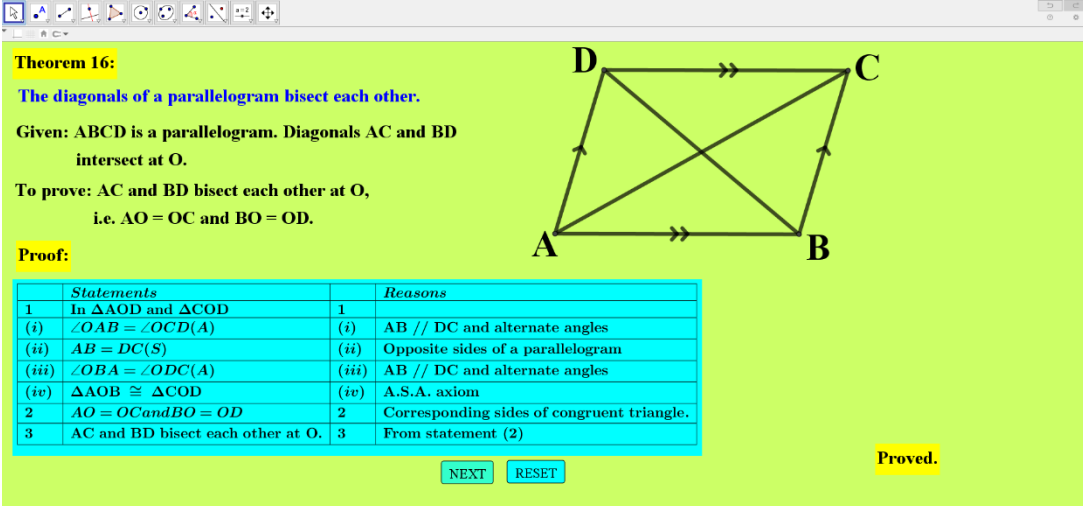
Activity-I: Discussion on the following questions with the use of GeoGebra.

- What is about the yesterday class?

- What are the special types of parallelogram?

- What is relation between diagonals of rhombus?

- What will be the happened the diagonals of parallelogram to each other.

Stage-II: Approach to the first objective.

Activity-I: Discussion on the following questions with the use of GeoGebra.

- Prove that, the diagonals of a parallelogram bisect each other.

Now, it's your turn:

- Prove that the diagonals of parallelogram bisect each other.

Teaching Episode-13

Subject: Mathematics   **Duration of lesson:** 40 min.

Chapter: Geometry   **Date:** 2077/11/

Teacher: Dipesh Prajapati   **Topic:** Parallelogram

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1. **Specific Objectives**

   On the completion of this lesson, the students will be able to

   i. To prove that, if the diagonals of a quadrilateral bisect each other, the

       quadrilateral is a parallelogram.

2. **Activities**

Stage-I: Warm up and review

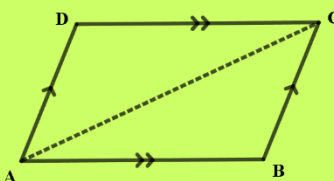   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - What is about the yesterday class?

   - What will be the converse statement of "the diagonals of a

     parallelogram bisect each other"?

   - What will be a quadrilateral? If the diagonals of the quadrilateral bisect

     each other.

Stage-II: Approach to the first objective.

   Activity-I: Discussion on the following questions with the use of GeoGebra.

   - Prove that, if the diagonals of a quadrilateral bisect each other, the

     quadrilateral is a parallelogram

Converse of Theorem 16:

If the diagonals of a quadrilateral bisect each other,

the quadrilateral is a parallelogram.

Given: ABCD is a quadrilateral in which diagonals AC and

BD bisect each other at O.

∴ AO = OC and BO = OD

To prove: ABCD is a parallelogram,

i.e. AB // DC, AD // BC, AB = DC, AD = BC.

Proof:

	Statements		Reasons	
1	In ΔAOD and ΔCOD	1		
(i)	$AO = OC(S)$	(i)	Given	
(ii)	$\angle AOB = \angle COD(A)$	(ii)	Vertically opposite angles	NEXT
(iii)	$BO = OD(S)$	(iii)	Given	
(iv)	∴ ΔAOB ≅ ΔCOD	(iv)	S.A.S. axiom	RESET
2	$AB = DC$	2	Corresponding sides of congruent triangle.	
3	$\angle OAB = \angle OCD$	3	Corresponding angles of congruent triangles	
4	AB // DC	4	From statements (3), alternate angles are equal	
5	$AD = BC and AD // BC$	5	AD and BC join the ends of two equal and parallel lines towards the same side.	
6	ABCD is a parallelogram	6	Opposite sides are equal and parallel	**Proved.**

Now, it's your turn:

- In the given figure, ABCD is a quadrilateral
  in which diagonals AC and BD bisect each
  other at O. Provethat ABCD is a parallelogram.
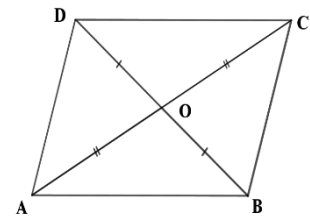
ANNEXES

Annex – 1

Score of Pre-test and Post-test

	Pre-Test			Post-Test	
S.N	Experimental Group	Control Group	S.N	Experimental Group	Control Group
1	33	30	1	36	33
2	27	32	2	32	36
3	34	29	3	36	31
4	28	15	4	31	20
5	9	10	5	22	13
6	11	13	6	23	18
7	10	8	7	23	16
8	9	9	8	20	16
9	18	15	9	26	20
10	22	21	10	29	22
11	13	20	11	25	23
12	19	9	12	26	15
13	11	15	13	18	16
14	21	6	14	30	19
15	10	19	15	24	23
16	24	20	16	33	24
17	8	28	17	23	31
18	15	11	18	26	15
19	11		19	23	
20	13		20	22	
Total	346	309	Total	528	391
Mean	17.3	17.22	Mean	26.4	21.72
S.D	8.09	7.95	S.D	5.02	5.89
t-value	0.03		t-value	2.64	

Annex – 2

Result of students' perception on GeoGebra

Themes	S N	Items		Strongly agree	Agree	Neutral	Disagree	Strongly Disagree	Total	Mean	Chi Square Value
Social interaction	1	GeoGebra helped to increase my questioning capacity to ask teacher and friends.	n. s.	17	16	2	3	0	38	4.24	35.42
			%	44.7	42.1	5.3	7.9	0	100		
	2	GeoGebra software made me very confident to express what I kwon about circle and parallelogram.	n. s.	17	15	6	0	0	38	4.28	34.37
			%	44.7	39.5	15.8	0	0	100		
	3	GeoGebra helped me to improve in geometry with the help of my existing knowledge.	n. s.	17	15	3	3	0	38	4.21	32
			%	44.7	39.5	7.9	7.9	0	100		
Self-exploration	4	I didn't like studying geometry lesson by using GeoGebra software.	n. s.	0	0	4	18	16	38	4.32	40.42
			%	0	0	10.5	47.4	42.1	100		
	5	I want to learn and use GeoGebra software myself.	n. s.	24	14	0	0	0	38	4.63	63.58
			%	63.2	36.8	0	0	0	100		
	6	I would like to learn more geometric concepts using GeoGebra.	n. s.	17	17	2	2	0	38	4.28	39.10
			%	44.7	44.7	5.3	5.3	0	100		
	7	I feel boring to learn by using GeoGebra software.	n. s.	0	0	4	5	29	38	4.65	78.05
			%	0	0	10.5	13.2	76.3	100		
Scaffolding	8	I can think creatively and critically when using GeoGebra software.	n. s.	18	13	6	1	0	38	4.26	31.73
			%	47.4	34.2	15.8	2.6	0	100		
	9	GeoGebra based teaching helps to learn easily about geometrical theorems and problems.	n. s.	12	22	4	0	0	38	4.21	46.73
			%	31.6	57.9	10.5	0	0	100		
	10	GeoGebra software helps to visualizing the problems related to geometrical concept.	n. s.	14	18	4	2	0	38	4.15	33.05
			%	36.8	47.4	10.5	5.3	0	100		
Overall mean = 4.32											

Annex – 3

Item Analysis of Test Items

S.N.	Upper (27%) 01	02	03	04	05	Average (46%) 06	07	08	09	10	11	12	13	14	Lower (27%) 15	16	17	18	19	Right Answers	P% Value	D Value	Remarks
1	1	1	1	1	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	7	36.84	0.32	Rejected
2	1	1	1	1	1	1	0	0	1	1	1	0	1	0	1	0	1	0	1	12	63.16	0.21	Accepted
3	1	1	1	1	0	1	1	1	0	1	0	0	0	1	0	0	0	0	0	8	42.11	0.42	Accepted
4	1	1	1	1	1	1	1	0	1	0	0	0	1	0	1	0	1	1	0	11	57.89	0.21	Accepted
5	0	1	1	0	1	1	1	1	0	1	0	0	0	1	0	1	0	0	0	9	47.37	0.21	Accepted
6	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	1	0	5	26.32	0.00	Rejected
7	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	1	0	0	11	57.89	0.32	Accepted
8	1	1	1	1	1	1	0	1	1	0	1	0	1	0	1	0	0	0	0	10	52.63	0.42	Accepted
9	1	1	1	0	1	1	1	0	0	1	0	1	0	0	1	0	0	0	0	8	42.11	0.32	Accepted
10	1	1	1	1	1	1	0	0	1	1	1	0	1	1	0	0	0	0	1	11	57.89	0.42	Accepted
11	1	0	1	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	6	31.58	0.21	Rejected
12	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	9	47.37	0.00	Rejected
1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	0	0	1	0	11	57.89	0.32	Accepted
2	1	1	1	1	1	1	1	1	1	0	1	0	1	0	0	0	1	1	0	12	63.16	0.32	Accepted
3	1	1	1	1	1	1	0	0	0	0	0	1	0	0	1	1	1	1	1	11	57.89	0.00	Rejected
4	1	1	1	0	1	0	1	1	1	0	1	1	1	0	0	0	1	0	0	10	52.63	0.32	Accepted
5	1	1	0	0	1	1	1	1	0	1	0	1	0	0	0	0	1	0	0	8	42.11	0.21	Accepted
6	1	1	1	1	1	0	1	1	1	0	1	0	1	0	0	0	0	1	0	10	52.63	0.42	Accepted
7	0	1	0	1	0	1	1	0	1	0	0	1	0	1	0	0	0	0	0	7	36.84	0.21	Rejected
8	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	12	63.16	0.53	Accepted
9	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	0	0	14	73.68	0.21	Accepted
	1	1	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	0	0	12	63.16	0.21	
																					68.42	0.21	
10	1	1	0	1	0	0	1	1	1	0	1	0	1	1	1	0	0	1	1	11	57.89	0.00	Rejected
	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	4	21.05	0.11	
																					39.47	0.05	
11	0	0	1	0	0	1	0	0	1	1	1	1	0	0	1	0	0	0	0	7	36.84	0.00	Rejected
	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3	15.79	0.11	
																					26.32	0.05	
12	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0	14	73.68	0.21	Accepted
	1	1	0	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	0	11	57.89	0.32	
																					65.79	0.26	
13	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	1	12	63.16	0.42	Accepted
	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	10	52.63	0.42	
																					57.89	0.42	
14	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	0	0	13	68.42	0.42	Accepted
	1	1	1	1	1	1	0	1	1	1	0	0	1	0	0	0	0	0	0	9	47.37	0.53	
																					57.89	0.47	
15	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	15	78.95	0.21	Accepted
	1	1	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	9	47.37	0.53	
	0	1	1	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	9	47.37	0.42	
	0	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0	8	42.11	0.42	
																					53.95	0.39	
16	1	1	1	1	1	1	1	1	0	1	1	1	0	0	1	1	0	0	1	13	68.42	0.21	Rejected
	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	7	36.84	0.53	
	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5	26.32	0.42	
	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5	26.32	0.42	
																					39.47	0.39	
17	1	1	0	1	1	1	1	0	1	0	1	1	1	1	0	1	0	0	0	11	57.89	0.32	Rejected
	1	0	0	1	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	6	31.58	0.21	
	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	3	15.79	0.11	
	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	5.26	0.00	
																					27.63	0.16	

Item																				Count	P%	D	Status
18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	14	73.68	0.42	
	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	12	63.16	0.53	
	1	1	1	1	1	0	1	1	0	1	1	1	1	1	0	0	0	0	0	11	57.89	0.53	Accepted
	0	1	1	1	1	0	1	1	0	1	1	0	1	0	0	0	0	0	0	9	47.37	0.42	
																					60.53	0.47	
19	1	1	1	1	1	1	0	1	0	0	1	1	0	1	0	0	0	1	0	10	52.63	0.42	
	1	1	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	1	0	7	36.84	0.42	
	1	1	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	6	31.58	0.53	Rejected
	1	1	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	6	31.58	0.53	
	1	0	1	1	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	5	26.32	0.42	
																					35.79	0.46	
20	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	13	68.42	0.42	
	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	10	52.63	0.53	
	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	10	52.63	0.53	Accepted
	1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	9	47.37	0.53	
	1	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	8	42.11	0.53	
																					52.63	0.51	
21	1	1	1	0	1	0	0	1	0	1	1	1	1	1	0	0	0	0	0	9	47.37	0.42	
	1	1	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	5	26.32	0.21	
	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	5.26	0.11	Rejected
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	
																					15.79	0.15	
22	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	13	68.42	0.42	
	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	11	57.89	0.53	
	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	10	52.63	0.53	Accepted
	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	9	47.37	0.53	
	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	0	0	0	0	9	47.37	0.53	
																					54.74	0.51	
T.S.	56	56	54	51	50	48	46	44	40	39	38	34	23	17	15	12	12	10	08				
O.I.	29	28	27	26	24	25	23	23	18	21	17	21	06	14	11	10	06	04	04				
E.I.	27	28	27	25	26	23	23	21	22	18	21	13	17	03	04	02	06	06	04				

Note: Rejected items if either P%-Value does not lie within 40 to 90 or D-Value is less than 0.20.

Interpretation Criteria for P Value	
Indicator (%)	Meaning
0 – 39	Very Difficult
40 – 60	General
61 – 75	Substantial
76 – 90	Easy
91 – 100	Very Easy

Interpretation Criteria for D Value	
Degree	Meaning
-1 – 0.19	Negligible
0.20 – 0.29	General
0.30 – 0.39	Good
0.40 – 1	Very Good

Annex – 4

Reliability Coefficient test of the test.

Number of Students	Score of odd Items(X)	Score of even items(Y)	Total	X^2	Y^2	XY
1	29	27	56	841	729	783
2	28	28	56	784	784	784
3	27	27	54	729	729	729
4	26	25	51	676	625	650
5	24	26	50	576	676	624
6	25	23	48	625	529	575
7	23	23	46	529	529	529
8	23	21	44	529	441	483
9	18	22	40	324	484	396
10	21	18	39	441	324	378
11	17	21	38	289	441	357
12	21	13	34	441	169	273
13	6	17	23	36	289	102
14	14	3	17	196	9	42
15	11	4	15	121	16	44
16	10	2	12	100	4	20
17	6	6	12	36	36	36
18	4	6	10	16	36	24
19	4	4	8	16	16	16
$N = 19$	$\sum X = 337$	$\sum Y = 316$		$\sum X^2 = 7305$	$\sum Y^2 = 6866$	$\sum XY = 6845$

	r_{xy}	**0.85**
	r_{tt}	**0.92**

Reliability of split half test, $r_{xy} = \dfrac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X)^2}\,\sqrt{N\sum Y^2 - (\sum Y)^2}}$

$$= \dfrac{19 \times 6845 - 337 \times 316}{\sqrt{19 \times 7305 - 337^2} \times \sqrt{19 \times 6866 - 316^2}}$$

$$= 0.85$$

Therefore, reliability of whole test, $r_{tt} = \dfrac{2r_{xy}}{1 + r_{xy}} = \dfrac{2 \times 0.85}{1 + 0.85} = 0.92$