EFFECTIVENESS OF GEOGEBRA IN TEACHING CIRCLE AT GRADE X: A QUASI- EXPERIMENTAL STUDY

A

THESIS

BY

SAROJ DEVKOTA

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TRIBHUVAN UNIVERSITY
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DEPARTMENT OF MATHEMATICS EDUCATION

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

पत्र संख्या:-
Ref.

मिति:
Date: .....

Letter of Certificate

This is to certify that Mr. Saroj Devkota, a student of academic year 2074/75 BS with thesis number 1757, exam roll. 7328452, Campus Roll.411, T.U. Reg.9-2-233-87-2012 has completed his thesis for the period of prescribed rules and regulations of T.U. Nepal. This thesis entitled "**Effectiveness of GeoGebra in Teaching Circle at Grade X: A Quasi-Experimental Study"** embodies the result of investigation conducted during December 2019 to April 2022 at the department of Mathematics Education, University Campus, Tribhuvan University, Kirtipur, Kathmandu. I hereby recommend and forward that his thesis be submitted for the evaluation to award the Degree of Master of Education.

Date:23 January, 2023 ……..

Asst. Prof. AbatarSubedi

(Head of Department)

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CENTRAL DEPARTMENT OF EDUCATION
DEPARTMENT OF MATHEMATICS EDUCATION

UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

पत्र संख्या:-
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Date: .....

Letter of Approval

A

Thesis

By

Saroj Devkota

Entitled

"Effectiveness of GeoGebra in Teaching Circle at Grade X:A Quasi-Experimental Study" has been approved in partial fulfillment of requirement for the Master Degree of Education.

Viva–Voce Committee	**Signature**
Asst. Prof. AbatarSubedi (Chairman)	……..
Prof. Uma Nath Pandey (External)	……
Mr. Krishna Prasad Adhikari (Supervisor)	…….

Date:30 January, 2023

2079/10/16 B.S.

Phone No.: 977-1-4331337 / 4333229, Fax No.: 4334955, E-mail : foe@tucded.edu.np, Website : tucded.edu.np

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UNIVERSITY CAMPUS
Kirtipur, Kathmandu, Nepal

पत्र संख्या:-
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Recommendation for Acceptance

This is to certify that Mr.Saroj Devkota has completed her M.Ed. Thesis entitled **"Effectiveness of GeoGebra in Teaching Circle at Grade X: A Quasi-Experimental Study"** under my supervision during the period prescribed the rules and regulation of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education to evaluate in the final viva-voce.

Date:23 January, 2023

.....

Mr. Krishna Prasad Adhikari

(Supervisor)

Phone No.: 977-1-4331337 / 4333229, Fax No.: 4334955, E-mail : foe@tucded.edu.np, Website : tucded.edu.np

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Declaration

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

Date: .....…….

Saroj Devkota

Dedication

Honestly dedicated

To

My parents

Acknowledgement

I am greatly indebted and I heartily express my extreme gratitude and acknowledgment to my respected supervisor Mr. Krishna Prasad Adhikari, Lecturer, Department of Mathematics Education, Central Department of Education, TU Kirtipur. He constantly advised and encouraged me so that I am able to complete this work.

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At last but not the least, I would like to remember every student who took part in the study without whom my study would not have been completed.

……..

Saroj Devkota

Abstract

This study entitled "**Effectiveness of GeoGebra in Teaching Circles at Grade X: A Quasi-Experimental Study"**. The purpose of this study was to investigate effectiveness of GeoGebra in teaching Circles at grade X and to explore the perception of students in teaching Circles by using GeoGebra software. The effectiveness was measured by comparing the achievement of the students taught by using GeoGebra software and without using GeoGebra software in virtual learning environment out of 28/25 students. The research was based on constructivist view of learning and the design of this study was quasi-experimental design. To gain the motto of this study the researcher adopted pre-test and post-test non-equivalent control group design.

Researcher used experimental design and selected two schools from the Makawanpur District. The researcher chose grade X, 28 students of Shree Sharada Secondary School, Makawanpur as the experimental group and 25 students of Shree Janak Secondary School, Makawanpur as the Control group. For the data collection researcher used Mathematics achievement test and questionnaire. The collected data were analyzed by using mean, standard deviation and t-test for quantitative data and for qualitative data descriptive and analytic methods were used.

The findings of this research showed that there is significant difference between the achievement of students taught by using GeoGebra software and conventional method of teaching mathematics in virtual learning environment. GeoGebra increase the participation of students in teaching and learning activities. Students were very excited for learning mathematics by using GeoGebra software. GeoGebra was very useful for visualization of mathematics and supportive to the students in revision. GeoGebra software is very useful and helpful in teaching

learning. The conclusion of this research is that the GeoGebra software needs to use at secondary level for meaningful and effective mathematics teaching learning in virtual learning environment.

The result of this study indicated that students in the experimental group have better achievement then control group. In addition, a five point Likert type of scale was used to elicit student's perception on the use of GeoGebra. Result of the questionnaire responses indicates a positive perception of using GeoGebra in Mathematics learning.

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Acronyms

CAS	= Computer Algebra System
DGS	= Dynamic Geometric Software
GSP	= Geometer's Sketchpad
GUI	= Graphical User Interface
ICT	= Information Communication Technology
MAT	= Mathematics Achievement Test
NCED	= National Centre for Education Development
NCTM	= National Council of Teacher of Mathematics
ZPD	= Zone of Proximal Development

Chapter I

Introduction

Background of the Study

As a result of the constructivist-based approach of the current mathematics curriculum, teaching and learning mathematics has improved substantially due to accessibility of educational technology, National Council of Teachers of Mathematics, (2003). The use of technology in teaching and learning has various benefits, such as increasing student learning possibilities Roberts (2012); increasing student engagement White (2012); and promoting discovery learning Bennet (1999). It is crucial for students to be able to see, create, and comprehend the structure of forms in order to connect them with relevant information while studying and teaching mathematics, especially geometry. Consequently, a computer will help pupils see and make observations Dogan (2010). There are several technology tools accessible, including calculators, interactive whiteboards, Geometers Sketchpad, and GeoGebra.

The development of science is built on a foundation of mathematics instruction. According to several studies, the mathematics subject is weaker than other subjects. This topic is regarded as the most challenging in the entire globe, and many students are terrified of it. Many pupils in Nepal see mathematics as being a challenging subject at the school level. More pupils fail this topic than succeed. Both parents and teachers admit it. In order to prevent students from dropping out of this topic due to difficulties, there needs to be practice using various ICT tools, and teaching and learning activities need to be visualized using various mathematical software at the school level, according to Bohara (2019).Here are some examples of various mathematical education software, including Matlab, GeoGebra, and Mathematica. At the school level, geometry has proven to be challenging for many

children. GeoGebra is an essential piece of math software that uses figures to illustrate geometric concepts. "The effectiveness of GeoGebra in teaching Circle in Grade X" is the topic I have chosen. Following my usage of GeoGebra for this study's research, I looked at the results.

One of the most well-liked technologies for math instruction and learning is dynamic geometry software, or DGS for short. DGS refers to any program that enables learners to draw geometric diagrams, analyze information like area, perimeter, and distance, and alter diagram elements while preserving their original geometric connections. Examples of this kind of software include GeoGebra, Geometric Sketchpad, Openboard, Smartboard, Liveboard, OneNote, and Active Inspire. The fact that students can utilize public domain DGS even at home and explore their ideas without their teacher’s presence is one of its key benefits. This suggests that pupils may learn mathematics even without teachers by examining, observing, and handling objects. Develop hypotheses and reach to their own conclusions, Burrus, Little, and Hannafin (2001).

A simple practice tool for studying and teaching mathematics, GeoGebra is one of the DGS types of software. It allows the teacher to distribute tasks as dynamic worksheets, or interactive webpages Hohenwarter, Jarvis, &Lavicza (2009). GeoGebra is a multi-platform, free, open-source, dynamic mathematics program that combines calculus, probability, and statistics with geometry and algebra. It may be used from preschool to university level. In fact, GeoGebra improves both student learning and the way education is imparted.This research discussed in detail the use and effectiveness of GeoGebra software in teaching learning circle.

Statement of the Problem

It has frequently been observed that students still lack the cognitive and processing skills necessary for a detailed knowledge of circles in geometry teaching and learning. Although the teacher imparts the necessary knowledge to let learners comprehend the principles of circles, students appear to struggle to apply this knowledge to a particular activity. It seems as though further assistance is needed to help students manipulate circle characteristics and theorems in order to fully comprehend and visualize them. Research by Battista (1999), Prescott, Mitchelmore, and White (2002) and others shows that learners have obstacles when studying geometry and frequently fail to understand the concept and necessary material.

The difficulty is greater when it comes to the learning and teaching of mathematics, in which teachers must balance the use of mental, physical, and digital resources for subjects like arithmetic that are difficult for students to comprehend Prieto, SordoJuanena, & Star (2013). Technology has a significant influence on how the educational process is established. Keser&Gursul (2009). The utilization of already-available technology resources by educators, like GeoGebra, Openboard, Math Lab, and Mathematica, should be leveraged. The usage of technology is crucial because it affects the learning goals and content and operates as a medium to strengthen the teaching and learning process. Voogt (2008).

To determine how GeoGebra may help teachers and students enhance their teaching and learning circles, a study on the effectiveness of GeoGebra in mathematics teaching circles must be conducted. The impact of utilizing technological tools (calculators and computers) in the teaching and learning of mathematics has been the subject of much debate during the past two decades Smith

(2002). Therefore, this study intends to demonstrate GeoGebra's usefulness by minimizing the challenges in the teaching and learning process in circle.

Research Questions of the Study

The research questions of this study are as follows:

1. What is the teachers and students perception towards the use of GeoGebra in teaching mathematics?
2. What is the effect of GeoGebra embedded instruction in the achievement of student in circle?

Justification of Study

The study's conclusions will assist instructors in better understanding how students learn, particularly how they utilize the GeoGebra math software. The results outline the procedures as well as the difficulties and concerns teachers utilizing GeoGebra software will need to take into account. The findings show how various interactions with colleagues, teachers, and technology impact learning. According to the Vygotskian viewpoint, it may become apparent how important social contact is for learning L.S. Vygotsky (1978). To put it another way, how students engage with peers and competent adults to enhance their cognitive abilities informs instructors about the application of GeoGebra software. The study also offers specifics on how learners with various capacities collaborate to accomplish assignments. Planning lessons for big groups and situations where students have a range of skills requires the application of this information. The study demonstrates how the use of technology aids in the learning and teaching of circles. In particular, the results assist in the reinterpretation of the teacher's responsibility so that ideas like "facilitator" and "guide at the side" may be better understood.

In addition, the study offers evidence on how learners of dissimilar skills interact to accomplish given tasks. Such information is vital in planning lessons for large classes and where learners are of diverse abilities. The study discloses how GeoGebra integration simplifies the teaching and learning of circles; precisely the findings help to redefine the role of teacher so that idea such as facilitator and guide at the side may become more deceptive.

The interface of GeoGebra is rather simple and intuitive, and it is divided into sections for algebra and geometry. The GeoGebra window offers a variety of views, including an algebraic view, a spreadsheet view, a CAS view, a protocol design view, and more. All of these viewpoints are interlinked, so if we offer an item in one aspect, it will appear in another in an appropriate manner. Every change made to a function's parameter is shown on a graph immediately. In addition to GeoGebra's standard features, such as drawing figures and graphing lines and functions, we can also use it to calculate or measure angles, points of intersection, lengths, fields, circumference, a function's maximum and minimum, derivatives, and integrals. It is obvious that GeoGebra may be used as a complex calculator, but not only, It is able to deal with matrices, vectors, and even a pair of linear equations.

Since a teacher may create dynamic demonstrations establishing dynamic interactions between components on the screen directly in front of a class, GeoGebra software is therefore a highly helpful tool for teaching mathematics. It appears ideal to utilize a projector. Students may create their own dynamic GeoGebra files, allowing them to quickly learn fundamental mathematical ideas that allow them to produce figures on their own. GeoGebra is beneficial for innovative learning where students may take charge and put their own unique accent on their work. GeoGebra contains a ready-made spreadsheet and supports a wide range of representations. It also

combines a lot of the capabilities of computer algebra systems and dynamic geometry applications. It appears to be a number of sellable bundles combined into one without cost. By dynamically exploring mathematics, students may overcome challenges. I think utilizing GeoGebra encourages you to approach problems from a mathematical perspective, especially when creating relationships between objects. GeoGebra is widely available and may be downloaded for free & directly from the internet.

Objectives of the Study

The general objective of this study is to explore the "effectiveness of GeoGebra in teaching and learning circle in Grade X. The study also seeks to determine whether this approach to learning is superior to the conventional approach and aims to obtain students' opinions in learning circles using GeoGebra.

More precisely the objectives of this study are:

1. To examine the effectiveness of using GeoGebra in teaching circle concept at secondary level mathematics.
2. To explore the perception of students towards the use of GeoGebra in teaching and learning circle at secondary level.

Hypothesis of the Study

H_0: There is no significance difference between achievement of students among two groups.i.e H_0: $\mu_1 = \mu_2$

H_1: There is significance difference between achievement of students among two groups.i.e H_1: $\mu_1 \neq \mu_2$

Delimitation of the Study

This study's foundation was:

- The circle chapter of secondary level mathematics.
- Pair of public schools of Makawanpur districtwas for the study.

- In experimental grouphad taken 28 students of Shree Sharada Secondary School and teach them about the use of GeoGebra Software in teaching, learning circle. Researcher hadtaught using Multimedia Projector for one week. Researcher hadobserved the students participation and effectiveness of such tools by checking their homework regularly.
- I used 25 Shree Janak Secondary School students in the control group for the study. Using the conventional way, the researcher had taught.(without using GeoGebra Software).

Operational Definition of the Key (Terms)

GeoGebra.As we have been facing pandemic situations for two years, the open learning software GeoGebra became an alternative and effective means in teaching learning mathematics. The concern towards use of GeoGebra has been increased all over the world. At the same time many attempts had done to use of the Geogebra effectively. Therefore, I used point, line, angle, polygon, slider tool to teachcircle in grade X.

ICT. Any communication equipment, including radio, television, mobile phones, computer and network hardware and software, satellite systems, and so on, is included in information communication and technology.

Effectiveness. The following items represent the study's assessment of efficacy:

- An improvement in the students' overall performance in math classes adopting GeoGebra.
- Obtain the students’ view towards GeoGebra in circle.

Public School.Public schools are those that get funding from the government for things like teacher salaries.

Traditional Instruction. Teachers are used to give instruction in face-to-face classrooms, when students passively listen and take notes.

Education technology.Digital hardware, software, and other tools are used in education for teaching and learning activities.

Experimental Group.A class of learners that have introduced to and regularly utilize GeoGebra during an grade ten teaching circle.

Control Group. Students who had received regular education in circles without the use of geometry.

ChapterII

REVIEW OF RELATED LITERATURE

Review of Empirical Literature

By helping children understand and comprehend circles through exploration, GeoGebra may help bridge the gap. Moreover, utilizing GeoGebra has an effect on students' comprehension of circles, according to a study of the research. GeoGebra is a computer application for mathematics, namely for studying geometry, algebra, calculus, statistics, etc. As per Hohenwarter, Jarvis, &Lavicza (2009). GeoGebra is described by Abramovich (2013) as a free online software program for the learning of geometry, algebra, and calculus at the grade level and with various teaching methods. Less effort has been devoted to studies on students' perceptions of using technology in mathematics classrooms. Li (2007).

"Perception of student on the use of GeoGebra in teaching Geometry" was the subject of a GeoGebra study conducted by Barai (2017). The study's objective was to learn how secondary school pupils perceived, participated in, and were motivated by the usage of GeoGebra. 22 kids from class 9 were chosen by the researcher to participate in the experiment. For the research design, the researcher employed a mixed technique. For the purpose of gathering data, the researcher employed questionnaires that included five-point scales of the Likart type. For quantitative data analysis, mean and standard deviation were employed, and theme analysis was used for qualitative data.Following data analysis, the researcher discovered that students' perceptions of utilizing GeoGebra in secondary-level geometry instruction were favorable.

Another study by Erhan & Andreason(2013)“Exploring Calculus with Dynamic Mathematics Software” It was also stated that learners' mathematical

knowledge has increased as a result of utilizing GeoGebra's dynamic geometry software. Students who were able to investigate and make hypotheses also performed better on tests. A conjecture in circle geometry states, in particular, that the measure of a central angle is the double of an inscribe angle with the same intercepted arc. Figure 1 illustrates the view of the GeoGebra file that has been set up to dynamically see this hypothesis given the connection between a central angle and an inscribe angle in the same arc. The inscribed and central angles in the GeoGebra content can be altered selectively using the α-slider.

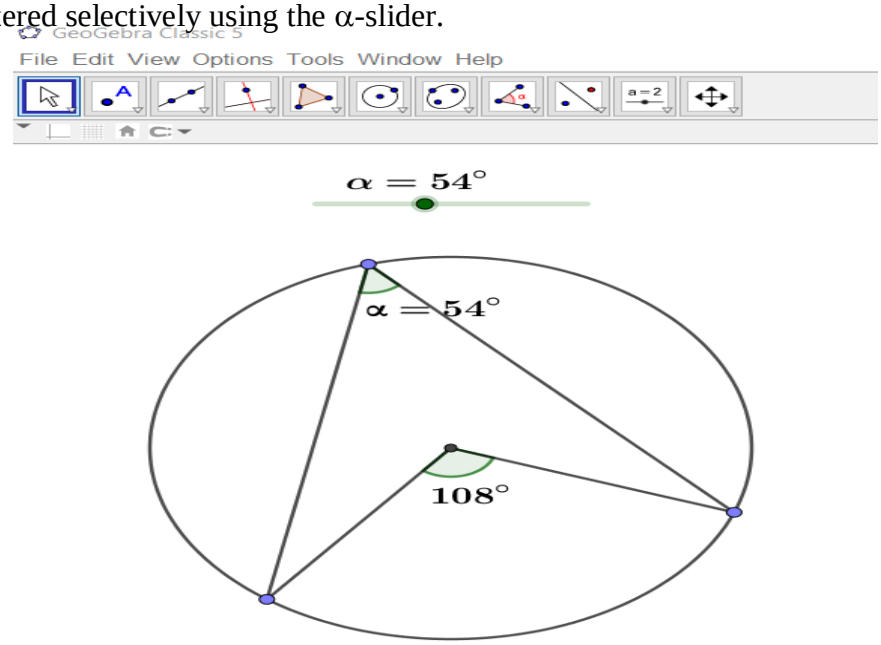

Figure 1: A illustration of the materials for the central and inscribed angle.

Herceg(2010) conducted a study on"Numerical Integration with GeoGebra in High School" among two groups of learners. The other group utilized both the GeoGebra program and applets, while the first group exclusively used applets. The study investigated the use of computer-based learning to improve the numerical integration process. According to the study's findings, the experimental GeoGebra group learned more and developed more abilities than the control group. According to this study, using GeoGebra might be beneficial for children who have trouble solving mathematical equations since it saves them time from having to do it by hand.

Dynamic software, as per Erhan &Andreason(2013), enhances students' knowledge of mathematics since it allows them to explore and generate hypotheses, which leads to improved overall grades.

Dogan (2010) performed an experimental design research utilizing a pre-posttest to assess how well students learned using the GeoGebra program. The study's topic was "The role of dynamic geometry software in the process of learning: GeoGebra." It was a 12-hour course that two eighth-grade classes took over the course of two weeks. The utilization of computer-based learning exercises was shown to be effective, and the GeoGebra program promoted more advanced thinking abilities. The program was also found to be effective in encouraging students to acquire and retain their information for extended periods of time.High ability grade 9 males thought the instruction was fascinating, according to Kemp (2006) findings in different research. Students were satisfied and involved in the session when applying the GeoGebra software, and they went above what the teacher had prescribed in terms of learning. It was advised that additional techniques be included to encourage the majority of students because the teacher was able to identify those students who faced difficulties in such a scenario and did not participate in the class.

In his review of a research titled "A survey on the effectiveness of Geoboard in teaching geometry at primary level" Paudel (2007) focused on this issue. The goal of the study was to contrast the academic performance of students who were taught using Geoboard with those who were not. For this study, the researchers selected a treatment group and a control group, with 25 students going into the treatment group and 20 students going into the control group. In order to analyze the data, mean, median, standard deviation, variance, and t-test were utilized. Data gathering methods included pre- and post-tests, surveys, and interviews. The study discovered that the

treatment group's results were superior to those of the control group based on the real classroom.

“Effectiveness of information communication technology integrated pedagogy at secondary level"was the subject of research by Sapkota (2015). The experimental and control groups of grade IX students were studied to determine the efficacy of information communication technology integrated pedagogy in the current system of education. For the study, 46 students from two public secondary schools in the Kathmandu district were selected. She came to the conclusion that, when compared to the present pedagogy, information and communications integrated pedagogy produces better results in terms of math achievement, and students who are taught using ICTIP are much more motivated to learn mathematics.

In order to ascertain the impact of utilizing the dynamic software Geometer's Sketchpad (GSP) in the teaching and learning of graph function, Leong (2013) carried out a research. Six secondary school students in Malaysia participated in this study. It was done utilizing an intact sampling method in a quasi-experimental approach. The experimental group's performance differs markedly from that of the control group in terms of accomplishment. This suggests that the dynamic software (GSP) had a favorable impact on students' academic performance and attitude toward comprehending graphs of functions.Belghesis&Kamalludeen (2018) submitted an article in the journal of educational technology on the subject of "Teacher intention to use GeoGebra in the teaching mathematics among Malaysian teachers." It was also investigated how teachers felt about using GeoGebra to teach arithmetic. The existence of the intention gap between male and female teachers was looked at. The study's objective was to ascertain teachers' intentions about the employment of GeoGebra in the teaching of mathematics in the classroom based on their current

skills. This study used a cross-sectional survey with quantitative analysisThere were 132 participants, all of them were math teachers who had taken part in a GeoGebra workshop at some time in their academic careers. Data were gathered using an online survey. A Likart scale measuring five points from 1 to 5 was used to collect responses (Strongly Disagree, Disagree, Undecided, Agree, Strongly Agree). 132 survey responses in all were tallied. There were 56 men and 76 women present. To evaluate the data, the researcher utilized the mean and standard deviation. Despite that discovery, there was no obvious difference between male and female students' motivation to utilize GeoGebra in math lessons.

In conclusion, many studies of the literature demonstrate that GeoGebra is a useful educational software and that the experimental group outperformed the control group in terms of learning outcomes. GeoGebra's ability to provide an engaging learning environment for students suggests that it plays a crucial part in both teaching and learning activities. A large number of researchers studied the efficiency of GeoGebra in tenth grade, while fewer researchers studied the subject of circles. Thus, the purpose of this study is to determine how well GeoGebra teaches geometry to grade ten students using a subject circle. It has a lot of potential for assisting students in developing understanding and recognizing the many angles while teaching geometry. Students may build a link between symbolic and visual representation by using the GeoGebra software application, which also greatly supports mathematics curriculum. Learning with GeoGebra is preferred to more conventional teaching and learning techniques.

Theoretical Review and Conceptual Framework

As opposed to knowledge being passively absorbed and accepted, students actively construct knowledge while building and evaluating figures in this research

using GeoGebra, which is based on Vygotsky's social constructivist approach. Every study is based on a distinct theoretical idea. The conceptual foundation of the study is provided by learning theory. GeoGebra enables the inclusion of students with a range of abilities and the development of their skills. Various learning theories form the foundation of teaching approaches. Constructivism was once used to separate traditionalists from constructivists. Many detractors claim that many authors use the term "constructivist teaching" to refer to any instruction that is a little "child centered" and inquiry-based. Megraw and Baher (2007).This claim demonstrates that learning is a process of individual effort and that knowledge is actively created by the learner.

"Constructivism inspires instructors" in the learning process. Students are continually encouraged to examine how an activity is advancing their learning by constructivist teachers. The goal of the constructivist classroom is for students to develop into "expert learners" through challenging themselves and their learning methods. They now have a wider range of tools to save their knowledge. The students learn how to learn in a well-designed learning environment. Students find that when they repeatedly reflect on their experiences, their thoughts get more complicated and powerful, and they gradually build up their capacity to absorb new knowledge. The primary responsibility of the teacher is to promote this process of learning and reflection Bhattacharjee (2015).

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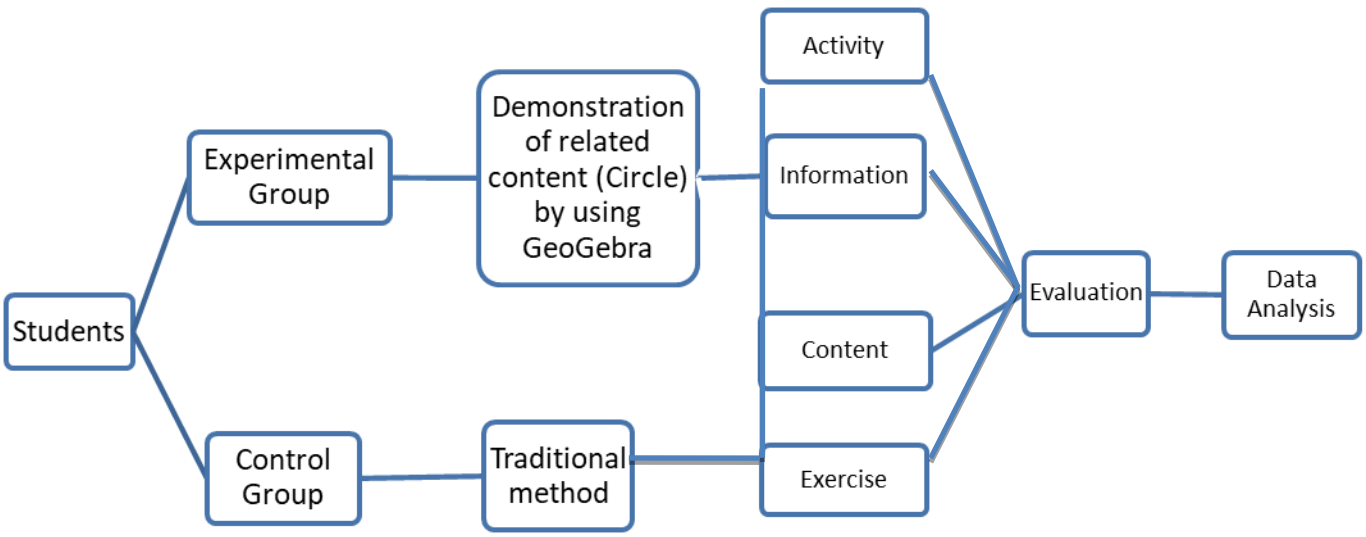
According to this claim, while the instructor serves as a facilitator, students are creative, dynamic, and self-motivated for learning activities. Glassford (1955) claimed that the constructivist method of instruction is not internally established. The learner continuously produces and completes knowledge. The learner's reaction to their world experience forms the basis of the resulting sequence of action. This shows that students build their own knowledge as they become used to the subject matter and the learning environment.

Conceptual Framework of the Study

The researcher can perform activities in the field of their selected topic with the help of a conceptual framework. In order to achieve the goals of this study, researchers were included in both the experimental and control groups. The experimental group of students was the center of the researcher's attention. GeoGebra was employed in the teaching procedure. The following diagram displays the study's conceptual framework.



In the experimental group, GeoGebra software was used while the control group received instruction using the conventional approach. The researcher looks at exercise, content, information, and activity, and gives activities based on a particular subject. In the experimental group, the researcher showed several visualizing shapes relevant to the course material. The student was inspired and given the chance to join an experimental team. In the end, the researcher assessed the students in both groups and assessed their attitudes regarding using GeoGebra in the experimental group.

For this research study, the researcher chose students from two government schools and established treatment groups and a control group. GeoGebra was used to teach the experiment group and to display the various content-related shapes. In the control group, GeoGebra software was not utilized; instead, standard teaching methods were employed. For both groups, the researcher selected the identical grade ten curriculum from the government of Nepal's CDC. Additional content was created with the supervisor's and the subject teacher's approval. Any content that assisted researchers and subject teachers in achieving educational goals requires the data. Information on topic matter was obtained using GeoGera and delivered to the experimental group of grade ten students. The research on exercise, information, and activity was based on a particular set of data. Teaching activities were undertaken for both groups on the same subject utilizing a variety of techniques and materials. Finally, both groups took a post-test to gauge the pupils' academic progress. Only the experimental group was used to gauge the students' attitudes regarding the GeoGebra program. Consequently, the final study's analysis and interpretation of the acquired data were complete.

Chapter III

METHODS AND PROCEDURES

The technique and procedures employed to perform the study are the main topics of this chapter. Additionally, this chapter covers the study's design, sample, instruments, method of data collecting, and method of data analysis.

Design of the Study

The research design is a thorough strategy of study. In actuality, it is a detailed outline of the process for gathering and evaluating data Singh (2007). The goal of research design is to offer as much information as possible that is important to the issue being studied. A study design essentially has two purposes. It begins by providing an impartial and reliable response to the research questions. The second function of a research design is as a control mechanism. In other words, it gives the researcher the ability to manage undesirable factors.

Experimental research, according to Best and Kahn (2006), defines what occurs when certain factors are precisely controlled or modified.

In that one or even more experimental factors are included, quasi-experimental research resembles actual experimental research. However, in this study organically constituted groups, like classrooms, were used as test subjects rather than randomly selected individuals. "Pre-test - Post-test Nonequivalent Group Design" was chosen as the quasi-experimental design because it is frequently used in classroom investigations because the experimental and control groups are such organically constructed groupings as entire classrooms, which may be comparable Best and Kahn (2006).

The table below shows the different groups and interpreted accordingly;

Table 1: Design of the study

Group	**Pre-test**	**Treatment**	**Post-test**
Experimental	A_1	Using GeoGebra	A_2
Control	A_3	Traditional method	A_4

$A_1$and A_3 stand in for the pre-test in this design, while A_2 and A_4 stand in for the post-test. Both groups will be taught on the same subject, with the experimental group utilizing GeoGebra software while the control group received instruction using the conventional technique.

Sample and Population of the Study

All of Nepal's secondary school pupils were used as the study's population in this investigation. However, I was unable to research the entire population because of a lack of time and resources. In such cases, the researcher's sample was limited to the Makawanpur district. In order to accomplish the goal of this study, the researcher selected two public schools out of convenience. A sample of the study was conducted with 28 students from Shree Sharada Secondary School and 25 students from Shree Janak Secondary School. If the researcher conducted the studies in class, there would be no false setting produced, making the sample for the experimental group more carefully chosen. In order to eliminate any potential effects of the exploitative variable on the control group, the sample for the control group was also carefully chosen to create an equal group to the experimental group. Both groups were taught by the researcher.

To achieve the goals of my study, I had picked the two schools from among the many government schools in the Makawanpur district. Although these schools are situated in the Makawanpur district's metropolitan region, no ICT resources are utilized in the teaching and learning processes. The teaching and learning

environments at both institutions are the same, and last year's outcomes were also the same. I selected these institutions as the focus of my investigation because of this.

Table 2: Composition of Samples

No. of Students	Groups of Students	Breakdown of Numbers	Percentage (%)
53	Experimental	28	53
	Control	25	47
	Total	53	100

Independent and Dependent Variables

When teaching mathematics to students in grade ten in the topic circle of this study, the researcher employed the dynamic mathematical program GeoGebra as the independent variable. The success of the students in circle as well as the perception of the students were provided as the dependent variables. Teaching aids, the academic environment at the school, and student participation are all considered external factors.

Variables are the circumstances or traits that the experimenter modifies, regulates, or observes. The characteristics or features that the researcher seeks to control or controls in an effort to determine how they relate to observable events are referred as the independent variables. The circumstances or traits that reflect or change when the researcher adds, eliminates, or modifies independent factors are known as dependent variables Khan and Best (2006).

Non-experimental factors include school features, instructor features that differ, students divided into two groups, and subject content. The mean, variance, and standard deviation of the two groups have been determined based on their marks to confirm the equality of the experimental and control groups.

Data Collection Tools

This study claims that pre- test and post-test performance tests, as well as a set of questionnaires, are essential data gathering tools. The researcher employed a questionnaire to evaluate how students felt about GeoGebra, and a subjective exam to evaluate how well the experimental and control groups of students had fared academically. The experimental and control groups performed pre- and post-testing and had those results analyzed.

Mathematics Achievement test. For the accomplishment exam, the researcher had created nine questions based on the grade ten book suggested by the CDC. The exam paper had been independently checked by the researcher, who then used item analysis to base his study. After that, difficult and simple exam questions had created and prepared. GeoGebra was used by the experimental group for the one-month instruction period, whereas the standard approach was used by the control group. The researcher tested both groups again after a month, using the identical questions as the initial exam. The results of the items' test, which were utilized to develop the mathematics achievement exam for this research study, were used to determine the test's reliability and validity.For the purpose of making the final conclusion in this research study, the data were interpreted from the scores that were acquired from the two groups and compared.

Questionnaire. The purpose of the questionnaire was to examine how students felt about the use of GeoGebra in math instruction. Nine questionnaire items from this study are based on a five-point Likart scale. Statements in this questionnaire represent how the pupils feel about using the GeoGebra program.

Data Analysis and Interpretation Procedure

The process of data analysis and interpretation is regarded as the design of any research project. The crucial next stage is data analysis and interpretation in order to arrive at an empirical solution to the issue after data collection with the use of appropriate tools and procedures Singh(2007). With the use of both inferential and descriptive statistics, the data analysis for this study was conducted quantitatively as well as qualitatively. As a result, statistics will be used to examine accomplishment test results. It will mostly be accomplished by comparing the mean scores of the two groups' pre- and post-test results. In order to determine how students in the experimental group exclusively perceive the dynamic geometrical application of GeoGebra, descriptive statistics were also utilized to examine the responses to the questionnaire.

Data Collection Procedure

The researcher collected the data for this research from the primary source. For this purpose, the researcher visited each sampled school along with achievement tests, requested letters from T.U. to get full support from the administration. After that, the researcher requested the headmaster and subject teacher for the experiment. The researcher selected two secondary schools for the pre-test and post-test. According to the analysis of pre-test and being a Secondary level mathematics teacher 28students fromSharada Secondary School, Makawanpur Gadhi-5, Makawanpur and 25 students fromJanak Secondary School, Makawanpur Gadhi-7, Makawanpur were taken for experimental and control group respectively then researcher selected two homogenous schools among five schools. The researcher separated these schools respectively experimental and control groups by tossing the coin. The experimental group was treated with GeoGebra assist teaching methods and the control group was

treated with the conventional method. After the treatment on both groups, the researcher took the post-test from both groups and analyzed the post-test and pre-test result in mean, standard deviation, and t-test. After treatment of the experimental group, the researcher took the interview of students to know the perception of students towards GeoGebra after completion of the experiment of classes. For the interview, questionnaires were based on creativity, curiosity, independence, and visual thinking. The researcher also used their own experience and observation to construct questionnaires.

Reliability and validity of achievement test

There are two types of reliability - internal and external reliability. Internal reliability assesses the consistency of results across items within a test. External reliability refers to the extent to which a measure varies from one use to another. The researcher used a correlation coefficient to establish the accomplishment test's internal consistency in order to assess the test's dependability. The Karl Pearson technique was used to assess the correlation coefficient, and the validity of the accomplishment test was established. Every researcher strives to have as much legitimacy as possible in their work. A valid experiment must contribute significantly to the advancement of knowledge Best and Khan, (2012). The specification grid and professional judgment were used to determine the validity of the accomplishment test.

Control Exercise

Extraneous variables are special types of independent variables that are secondary interest of the researcher but controlled through research design or statistical procedures to increase the validity of the results. Same subject matter was taught in both experimental and control groups by the researcher himself within equal time duration. Same test was administered in both groups, experimental and control

before and after the experiment. Point scoring system was applied for the purpose of scoring the answer sheet. Interaction effect among students was controlled by maintaining the distance two schools.

Teaching Episodes

To accomplish the objectives of this study researcher had constructed seven teaching episode from the chapter circle of grade X recommended by CDC Nepal. Among the two episodes were based on theoretical and five episodes were based on practical. The researcher had prepared the lesson plan for each episode based on constructive learning approach by keeping GeoGebra as a major tool.Such episodes prepared by the researcher had attached and saved as appendix of this study.

Ethical Considerations

Ethical Consideration is very important to be considered by researchers while collecting information. So, the researcher considered informants' personal matters, organization’s own rules. The informant’sweren’tbeing imposed to give answers. They were requested at their own pace. This study was conducted for the academic purpose while collecting data, ethical considerations were ensured for the primary data privacy. The researcher took permission from the school administration of schools. Regarding to study, the researcher was clearly informed of his objectives to respondents. The researcher built trust with the respondents. The researcher didn’t bias socially, culturally, ethically while selecting the schools as the research sample. The researcher did respect the respondent's answers. He did not use the data for another purpose except his research.

Chapter IV

ANALYSIS AND INTERPRETATION

This section deals with analyze and interpretation of the data which is obtained from the survey of this study. This part is taken as the heart of the thesis because of the conclusion is made based on this part. The result of this study is made from the result obtained by hypothesis test.

Analysis of Pretest Result

The result obtained from the pretest of the experimental group and control group can be summarized below:

Table 3: Result of Pretest

Group	N	Mean	Variance	Standard Deviation	F	α	Calculated t- value	Tabulated t- value
Experimental	28	18.93	26.85	5.18	1.26	0.05	0.27	1.96
Control	25	18.44	21.28	4.61				

According to the following statistics, the Experimental and Control groups each had 28 and 25 participants. A 30-point Mathematics accomplishment exam was administered as a pre-test, and the passing score was 10. (See test questions in appendix – H and score of students in appendix – F). The Experimental group's Mean, Variance, and Standard Deviation were 18.93, 26.85, and 5.18, respectively. Similar to the experimental group, the control group's mean, variance, and standard deviation were 18.44, 21.28, and 4.61, respectively. The t-test for combined variance was used since the groups were similar based on the F value of 1.26. Given that it was a two-tailed test with a 5% level of confidence,so, $\alpha/2 = 0.025$ the tabulated t-value was 1.96 with a 0.05 level of significance Although H (O) was approved, the estimated t-value of 0.27, which didn't include in the critical zone (0.271.96), suggests that there is no

significant difference in the academic success of students in the two groups. Therefore, it is possible to draw the conclusion that there is no significant difference between the experimental and control groups in the accomplishment pre-test. But the group's pre-test performance was essentially the same.

Result of the posttest

The result of the posttest of the experimental and control group can be summarized below:

Table 4: Result of Posttest

Group	N	Mean	Variance	Standard Deviation	F	α	Calculated t-value	Tabulated t-value
Experimental	28	25.96	26.85	5.18	2.28	0.05	3.61	1.645
Control	25	21.64	11.75	3.43				

According to the table, the experimental group contains 28 pupils, whereas the control group contains 25. The Experimental group's Mean, Variance, and Standard Deviation were 25,96, 26,85, and 5,18, respectively. However, the Mean, Variance, and Standard Deviation of the control group were 21.64, 11.75, and 3.43 respectively, as determined by the post-test mathematics achievement exam. Each person's score was recorded in appendix G. The combined variance t-test technique was used since both groups were similar and the result of F was 2.28.It is a one-tailed test with $\alpha = 0.05$ in this case. The fact that H_0 was rejected since the estimated t-test result was $3.61 > 1.645$ suggests that there is a significant difference between the academic performance of the students in the two groups. Therefore, it may be said that on the post-test, the experimental group's average performance is greater than the control group's average performance. Thus, the GeoGebra software is a more effective tool for increasing student achievement.

Comparison between Pretest and Posttest Result

Among 28 students of the experimental group the mean, variance and Standard deviation of the pretest result was 18.93,26.85 and 5.18 respectively whereas the mean variance and standard deviation of posttest result was 25.96, 26.85, 3.43respectively. This result shows that the mean of the post test result is greater than the mean of the pretest result, that means the use of GeoGebra in teaching circle is effective.

Result of Student Perception towards GeoGebra

Nine questions on a questionnaire were used to gauge the students' perspective. Only to learn their perspective based on their experiences using the GeoGebra software, the experimental group was given the questionnaire. Positive outcomes are revealed by the questionnaire's findings.

The first response on the questionnaire, "I enjoy to using GeoGebra Software," has the highest mean, as seen in Table 5. These kids had never before used GeoGebra. They probably liked using the GeoGebra math learning program for these reasons. According to Lunar et al. (2010), using computers in teaching and learning improves students' motivation as well as performance. According to Figs. 5 and 6, students who selected "strongly agree" had the greatest percentage of replies overall. This demonstrates the pupils' enthusiasm for utilizing the GeoGebra program to study mathematics.It demonstrates how using software to learn might potentially result in interaction across activities. Students' motivation in learning mathematics increased as a result of their interactions during lessons.

Table 5: Result of Perception Test

S.N.	Items	Minimum	Maximum	Mean	Standard Deviation
1	I enjoy theclassroom with usingGeoGebra.	3	5	4.62	0.561
2	GeoGebra Software helps to learn Mathematics concepts.	3	5	4.22	0.641
3	I feel confident when the activities done by using GeoGebra Software.	3	5	4.10	0.618
4	I learnt a lot about mathematics when using GeoGebra software.	2	5	4.21	0.819
5	I can think creatively and critically when using GeoGebra software.	2	5	3.93	0.842
6	I prefer to learn mathematics with GeoGebra software.	1	5	4.28	0.996
7	GeoGebra software can help to increase my achievement in mathematics.	3	5	4.31	0.761
8	I am excited when asked to explore the GeoGebra software.	3	5	4.25	0.752
9	I am happy if the teacher uses the GeoGebra software in teaching mathematics.	1	5	4.45	0.948
Overall Mean			**4.26**		

The item on the questionnaire that said that pupils can think critically and creatively had the lowest mean, according to the research, with a mean of 3.93. where the first item, "I enjoy the classroom with using GeoGebra" has the highest mean of 4.62. The entire mean, according to table 5, is 4.26. This shows that, on the whole,

students concur with remarks made in favor of GeoGebra.The outcome of the questionnaire shows that the students who enjoy the classroom using GeoGebra has standard deviation 0.561 which is the lowest among all, implies thatthe students who enjoy the classroom with GeoGebra and the perspective of students towards it has strong similarities.Students discovered that GeoGebra is an excellent way to demonstrate what they learned in math class. From the findings, it can be inferred that utilizing GeoGebra software helps to increase students' motivation for studying mathematics as well as their interest in doing so.

Students frequently benefit from using GeoGebra software to study mathematics since it allows them to connect with technology. Computer-literate students in the twenty-first century will pay close attention to possibilities to study with the aid of technology. To connect with others, they utilize the Internet, mobile devices, landlines, laptops, PCs, tablets, and other applications. Students are motivated to learn mathematics in a digital setting. Additionally, it motivates instructors and students to participate in teaching and learning.

Numerous scientific studies now demonstrate that using computers has improved student motivation and self-confidence as well as making it simpler to learn mathematical ideas.

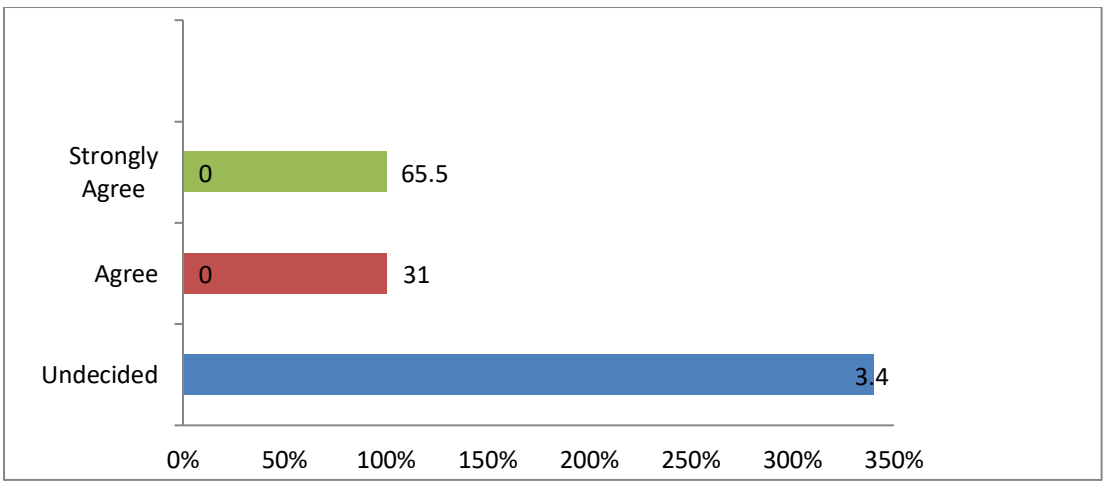


Figure 1: The Percentage of 'like to use GeoGebra Software'

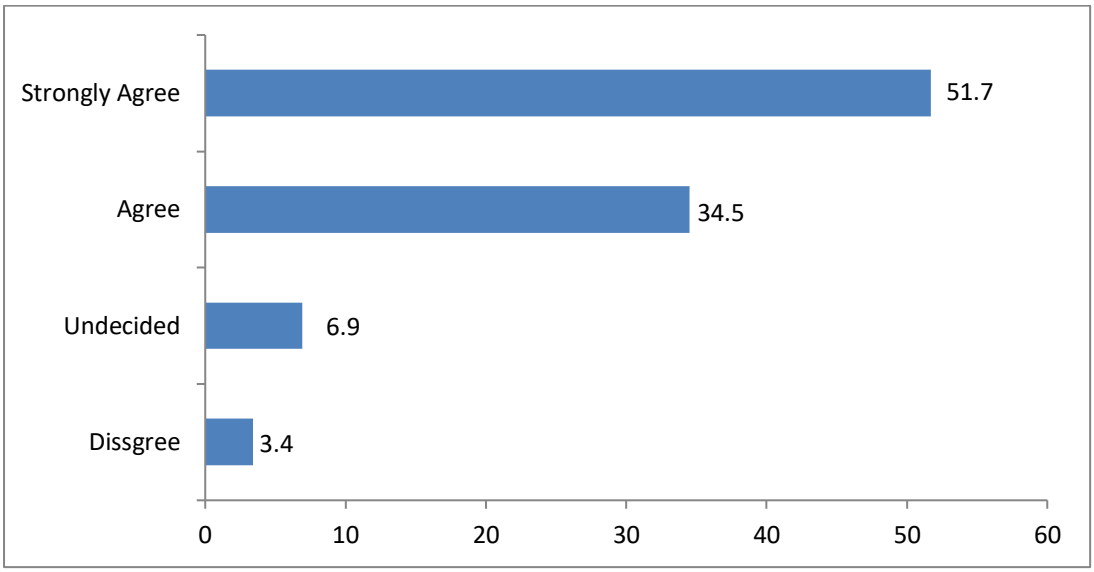


Figure 2: The percentage of students who prefer using GeoGebra software to learn mathematics

Discussion

In this 21st century, many tools and methods have been developed for the teaching and learning mathematics. As we have been facing pandemic situation since two years the GeoGebra software has been used the most. Using this software we can enhance the effectiveness of the teaching learning activities also we could able to increase the student's participation in learning activities.We could able to increase the learning outcomes making learning activities conceptual, permanent, creative and effective using such new technologies Geometrical concept like line,angle, ray, and geometrical figure like triangle, quadrilateral, circle can be taught well using this software. Traditional ways of teaching avoids the student's participation while modern class room focuses on the active participation to make learning meaningful, conceptual, permanent and effective.

Given that experimental students' conceptual grasp of circles was significantly higher than that of the control group, GeoGebra can be utilized to facilitate the

teaching and learning of mathematics, especially of circles. In addition to raising students' test results, GeoGebra was shown to promote a dynamic learning environment in which collaborative and cooperative learning concepts were illustrated. To understand mathematical ideas, two groups of participants in this study took a pre- and post-achievement test.

The students in the experimental group scored higher on their post-test performance than their pre-test performance, despite the fact that the results of the study that claimed "There is no significant differences between the pre-test and post-test performance of students teaching circle by using GeoGebra software and without using GeoGebra software" showed otherwise. It follows that there was a notable difference between the pre-test and post-test results of pupils who were taught mathematics using the GeoGebra program.

The aforementioned findings also support research conducted to ascertain how a technology-rich environment affects students' learning. The constructivist learning environment's design, which is based on the twin principles of scaffolds and the zone of proximal development, can be credited with this improvement. Therefore, it is equally crucial that the teacher, who serves as the primary designer of the learning environment, is informed about the benefits of a digital classroom. When analyzing the effects of new educational technologies, professional mathematics studies should always be acknowledged. The document "Principles and standards for School Mathematics" listed technology as one of the fundamental ideas to improve the level of talent of mathematics, recommending that "Teachers should use technology to enhance their students' educational process by choosing or generating mathematics problems that benefit of what technology can do proficiently and well-graphing, visualizing, and computing." NCTM (2000).

The findings also imply that technology is an excellent motivator since students' self-confidence increased when GeoGebra and instructional films were combined to improve their learning. The less gifted children benefited the most from this. As a scaffold, technology helped students get to their Zone of Proximal Development. Vygotsky(1978). This conclusion is reinforced by a research by Dogan (2010), which found that computer-based activities boosted students' motivation for learning and improved higher-order thinking skills.

When asked how the program had changed them, students reported a variety of beneficial effects, including increased learning engagement and the ability to think more critically. In a related study, Kemp (2006) discovered that high ability year 9 boys considered the lesson to be engaging and that they were satisfied and interested in the class. Students were also able to develop their learning beyond what the instructor had given. Additionally, Geometer's Sketchpad software had a good impact on students' achievement and attitude toward mathematics, according to a research by Leong (2013) on Form Six students in a Malaysian Secondary School.

Chapter V

SUMMARY, FINDINGS, CONCLUSION AND IMPLICATIONS

It is crucial to present a concise overview, results, conclusions, and consequences of any research when it has been completed. The goal of the study, as indicated in chapter I, was to identify the barriers to increasing e-learning in mathematics education. The summary, findings, conclusions, and consequences relating to the students' challenges in promoting digital technology in mathematics learning are covered in this chapter. The findings of this study have produced following detailed analysis and interpretation of the findings of the data. Based on these findings, inferences have drawn, and implications have advanced at several levels. The four elements that make up this chapter are summary, findings, conclusions, and educational implications.

Summary of the Study

The purpose of the study, "Effectiveness of GeoGebra Software in Teaching Circles in Grade X", was to determine if GeoGebra yields superior results in terms of students' academic performance and perceptions of GeoGebra when used in circles as compared to the traditional technique.

The non-equivalent pre-test, post-test control group design was used in the study. The objectives of this study were to determine the efficiency of utilizing GeoGebra in secondary level mathematics instruction of the circle idea and to understand what students thought of its use.

Researcher gathers data from Mathematics achievement exam and perception test of this experimental group after teaching for one week at Sharada Secondary School using GeoGebra software, while control group was taught using the usual traditional manner in Shree Janak Secondary School. According to chapter one, there

were two hypotheses created for this study. To ascertain the students' starting arithmetic background, the Pre-test results were put to a t-test. There was no apparent difference in the mean scores between the two groups, according to the t-test results shown in Table 3. Using t-test statistics, the second hypothesis, as shown in Table 4, was disproved at the 0.05 level of significance.By implication, students taught with GeoGebra performed better in the post-test than the pre-test in Student Achievement Test in Mathematics.

It follows that pupils who were taught GeoGebra scored better on the Student Performance Test in Mathematics post-test than it did on the pre-test. GeoGebra has proven to be a useful tool for teaching and learning about circles in this study. This was demonstrated by the higher grade received by the experimental group of students. The outcome demonstrated that pupils in the experimental group excelled those in the control group utilizing the conventional teaching technique while using GeoGebra. Additionally, experimental group students performed better on the post-test than control group students. Nine items in a which was before questionnaire were used to evaluate the students' perspective. Only to learn their perspective based on their experiences using the GeoGebra program, the experimental group was given the questionnaire. The result obtained from the questionnaire shows positive result.

Findings of the Research

As we have been facing COVID-19 problem (pandemic situation) for two years, the digital technologies are playing vital role for learning mathematic. It's not only in pandemic but also in other situation its effective use make student clear understanding regarding to the mathematical concept avoids rote memorization. Now a days it's being lucrative in learning mathematics. Besides much strength of digital

technologies there are many difficulties and challenges in its effective use and management.

On the basis of analysis and interpretation of the data, the major finding of this research can be mentioned below:-

- Skillful, knowledgeable, competitive, innovative and creative manpower regarding to technology is required. Also, the participation of the students in such work has been growing.
- Clear in conceptual aspects in related content.
- Use of GeoGebra stablished theconcrete and sustainable understandingon content among students.

Conclusions

This study has shown that GeoGebra is a useful tool for improving mathematics instruction and learning, particularly in learning circles. In contrast to being only passive learners, students were given the opportunity to engage in hands-on learning, which helped them better understand the concepts..

Through inquiry and visualization, this program provided teachers and students with options. GeoGebra is a useful tool for helping the math teacher and the students in the classroom use the constructivist learning ideas. This backs up the conclusions reached by Akkaya, Tatar, and Kagizmanli (2011). It is strongly advised that instructors be encouraged to utilize the GeoGebra software in the teaching of mathematics in light of the findings of the current study. To clearly determine whether GeoGebra does in fact have an impact on student learning of more general mathematical ideas and on different levels, this should be combined with research to make meaningful findings.

This study compares the academic performance of students taught using GeoGebra to that of students taught using conventional/traditional techniques. It also looks at how students feel about using GeoGebra to teach and learn mathematics. This research is valuable researches in mathematics teaching. GeoGebra plays a significant role in the improvement of achievement in teaching mathematics. The achievement of the experimental group was better than the control group. Students have a positive perception towards GeoGebra assist teaching. Students were motivated in learning mathematics. GeoGebra helped students with conceptual learning and for revision by self-study. The use of GeoGebra in the learning Circle increased overall student motivation, engagement, and achievement.

In conclusion, our research has demonstrated that GeoGebra software has a beneficial effect on students' success in the Circles topic. In terms of passion, assurance, and motivation, the students also had favorable opinions about the GeoGebra software. Teachers of mathematics should be made aware of this software so that students can study the field of mathematics more widely and develop their ability to think strategically and creatively. There was in-depth participation of students in classroom interaction and problem-solving. GeoGebra helped students to unlock their hidden talent. It would be better if the curriculum development center includes the GeoGebra at the secondary level. The use of GeoGebra software is very effective in the virtual teaching-learning environment in the present context of the world. Regarding the above outcomes, it can be concluded that the proper& continuous utilization of science & technology leads students to achieve positive changes in learning.

Implications of the Study

The researcher provides the following implications after analyzing the data, drawing conclusions from this research, and discussing the current study.:

Implication for Policy Level. The instructor should be encouraged by the Ministry of Education and NCED through training to utilize GeoGebra to enhance the current mug and jug approach. For this, NCED and MOE should plan numerous seminars, conferences, training programs, etc. The findings of this study also suggest that policy makers should consciously promote the usage of GeoGebra software that produces inferior learning results.

Implication for Practice Level. The major implications of this research are as follows:

- This study will be useful to the different schools and institutions.
- This type of research can be done in other primary, basic and higher level of education.
- The teacher should motivate the weak students and praise them to participate in teaching learning activities by using the GeoGebra.
- This software can be utilized in the other branch of mathematics such as arithmetic, algebra and statistic etc.
- Students can gain a clear concept and they can be explained both the facts and the concept to the students for understanding abstract ideas at later.
- Both teachers and students prioritized GeoGebra for clear understanding and enhancing the use of technologies in the field of mathematics learning inside as well as outside of the classroom.
- This study helps the school administrator to maximize the use of the relevant technologies in learning mathematics with minimum cost and effort.

- Teachers should be dynamic, updated, innovative, creative, trained and professional along with the amicability, fervor, hardworking and fortitude.
- Teachers and students should seek new technologies that can be used in learning mathematics so that students could able to get a clear concept.
- It enhances the active participation of the students in learning mathematics.

Recommendation for Further Study. This study is a quantitative research entitled by "Effectiveness of GeoGebra in Teaching Circle at Grade X" which is done to accomplish "To examine the effectiveness of using GeoGebra in teaching circle's concept at secondary level mathematics, to explore the perception of students towards the use of GeoGebra in teaching and learning circle at secondary level". As this study is done taking the students of the one school as sample, others other research can be done on the same topic. The major recommendation of this research can be mentioned below:

- Further research can be done in effective use of GeoGebra in teaching learning mathematics.
- Higher level research may be done in this area.
- I have taken only the public school as an area of study for this research. Taking many private and others institutions as an area of study such type of research can be done.
- The study area of this research can be extended like other development regions and other part of country.
- Research in same topic with different tools and method.
- Recommended for research as "The achievements of the students taught by using digital technologies and without using digital technologies".

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Appendices

Appendix – A

Teaching Episode – 1

Subject: Introduction to GeoGebra Software

Duration of lesson: 45 minutes

Target Group: 10^{th}graders (14 – 16 years old)

Teachers: Saroj Devkota

Cooperating teacher: Tirtha Khadka

Date:

I. Prerequisites:

Students are familiar with basic computer operations. They are supposed to be able to know about mouse and keyboard as inputs and to monitor corresponding outputs on the screen.

II. Required Materials:

Computer, projector, projection screen etc. GeoGebra 5.0 Software is required.

III. Learning Objectives:

At the end of this first lesson the students should be able to:

- Recognize the working environment and some menu and toolbar of GeoGebra window.
- Recognize some basic tools as well as motion slider in GeoGebra.

IV. Activities:

Lesson (This was first day for experiment so that researcher not teaches about circle but he primarily focus about introducing students to GeoGebra software, features and application of this software with demonstrating following activities by power point.)

1. Students were watchfully motivated when researcher saying various quotations related to the mathematical definition.
2. He was briefly explained about development as well as application of mathematics by the used of slider.
3. After that he was described about GeoGebra Software.
4. All parts of Circles in animated sliders were demonstrated by me.
5. Then, various features and applications were explained by me.
6. GeoGebra Software was opened by me then algebraic view, graphical view, spreadsheet view as many menu bar, tool bar, motion slider and so on of GeoGebra window were demonstrated to students with brief explanation where and how they could be used in teaching scenario.

Teaching Episode – 2

Subject: Circle (Theorem – 8)

Duration of lesson: 45 minutes

Target Group: 10^{th} grade (14 – 16 years old)

Teachers: Saroj Devkota

Cooperating teacher: Tirtha Khadka

Date:

I. Prerequisites:

Students are familiar with basic concept about circle such as radius, Centre and circumference and so on. Required Materials:

II. Teaching Materials:-

Computer,projector,projection screen etc. GeoGebra 5.0 Software is required to be installed in computers.

III. Learning Objectives:

At the end of this first lesson the students should be able to:

- Prove the theorem the central angle of a circle is double of the inscribed angle standing on the same arc by experimental verification.

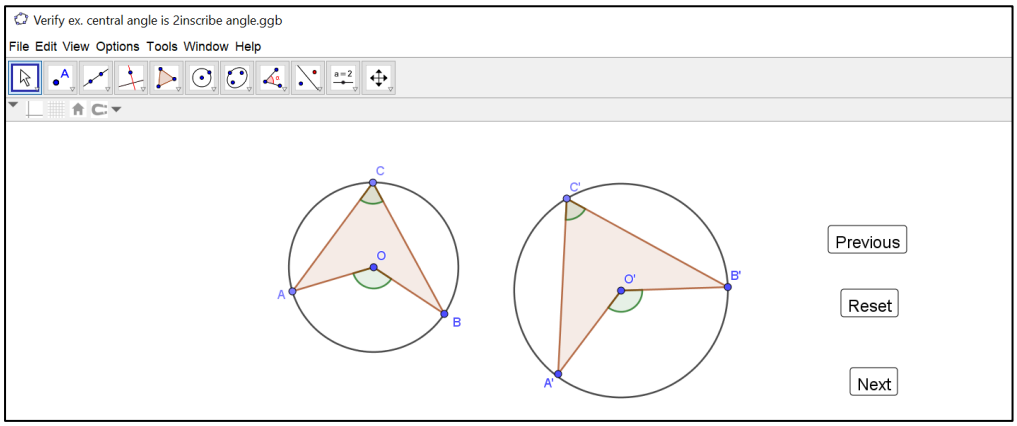
IV. Activities:

Lesson

A. Teaching learning activities by using GeoGebra is a new strategy for our Nepalese students therefore the researcher demonstrates the activities by using GeoGebra Software.

B. Researcher draw three circles of different sizes, Taking an arc BC, draw an inscribe angle < ACB and central angle < AOB standing on same arc in

graphical view of GeoGebra and then researcher ask to students to make above mentioned facts by using compass as well as protector in their copy.



C. Researcher should measure the central angle and the inscribed angle by using GeoGebra software and tabulate the measurement in the following table in which researcher used GeoGebra to fill the following table. But students should measure the central angle and the inscribe angle by using protector software and tabulate the measurement in their copy.

Fig.	Central angle<AOB	Inscribe angle<ACB	Result
i)			<AOB = 2 <ACB
ii)			

D. Researcher should ask to students what conclusion was derived. Students should give answer as here, the central angle AOB is double of the inscribe angle ACB standing on the same arc AB. Thus, the central angle of a circle is double of the inscribe angle standing on the same arc was conclusion.

Teaching Episode – 3

Subject: Circle (Theorem – 9)

Duration of lesson: 45 minutes

Target Group: 10^{th}graders (14 – 16 years old)

Teachers: Saroj Devkota

Cooperating teacher: Tirtha Khadka

Date:

I. Prerequisites:

Students are familiar with the theorem of central angle of a circle is double of the inscribed angle standing on the same arc.

II. **Teaching Materials:-**

Computer, projector, projection screen etc. GeoGebra 5.0 Software is required to be installed in computers.

III. Learning Objectives:

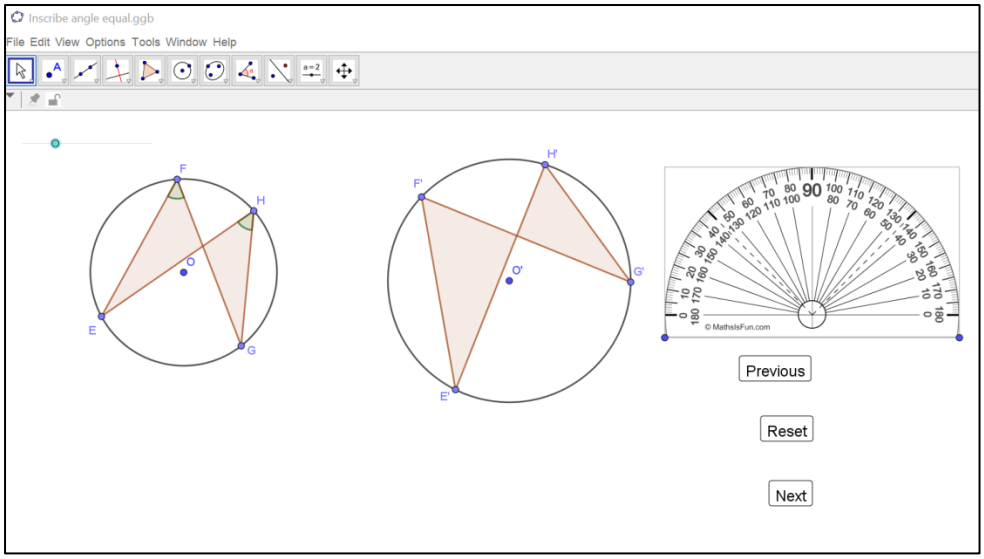
At the end of this first lesson the students should be able to:

- Prove the theorem inscribed angle standing on the same arc of a circles equal by experimental verification.

III. Activities:

Lesson

1. Researcher draw two or more than two circle ABC of different radii by GeoGebra software in which he take a point in the segment BC of each circle and draw <EFG. Again, take another point D in the same segment BC and draw <EHG and then researcher ask to students' to make above mentioned facts by using compass as well as protector in their copy.



2. Researcher should measure the angle < EFG and < EHG subtended by the same arc EG of each circle by using GeoGebra software and tabulate the measurement in the following table in which researcher used GeoGebra to fill in the following table. But students should measure the inscribe angles by using protector software and tabulate the measurement in their copy.

Fig.	Inscribe angle<EFG	Inscribe angle<EHG	Result
i)			<EFG = <EHG
ii)			

3. Researcher should ask to students what conclusion was derived. Students should give answer as here, the inscribe angles formed on same arc EG, <EFG = <EHG. Thus, the inscribe angle of a circle are equal standing on the same arc was conclusion.

Teaching Episode – 4

Subject: Circle (Theorem – 10)

Duration of lesson: 45 minutes

Target Group: 10^{th}grade (14 – 16 years old)

Teachers: Saroj Devkota

Cooperating teacher: Tirtha Khadka

Date:

I. Prerequisites:

Students are familiar with basic concept about circle such as radius, Centre and circumference as well as have the knowledge of both of above theorem.

II. Required Materials:

Computer, projector, projection screen etc. GeoGebra 5.0 Software is required to be installed in computers.

III. Learning Objectives:

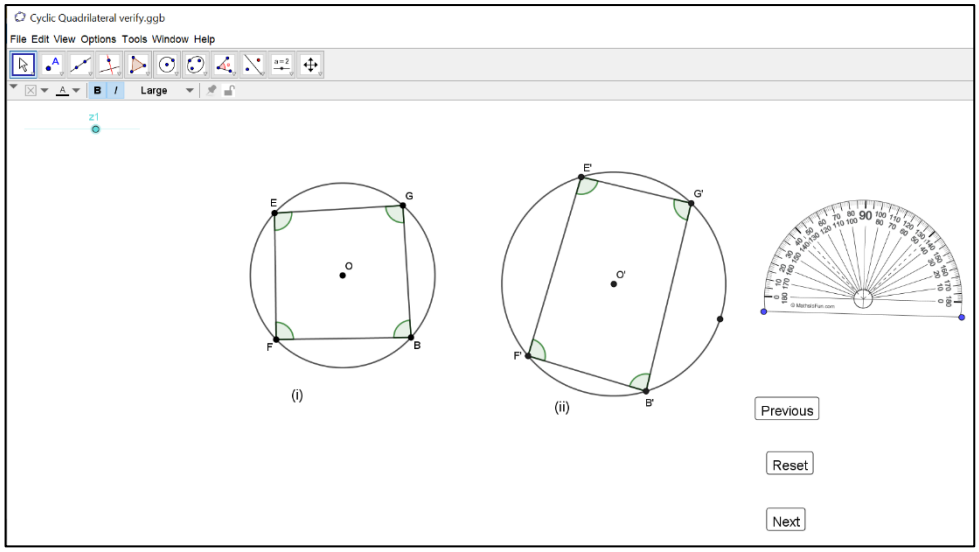
At the end of this first lesson the students should be able to:

- Prove the theorem the sum of the opposite angles of a cyclic quadrilateral is equal to two right angles by experimental verification.

IV. Activities:

Lesson

1. Researcher draw two or more than two circle FBGE of different radii with Centre Oby GeoGebra software.Take any four points F, B, G and E on its circumference and draw a cyclic quadrilateral FBGE in each circle and then researcher ask to students' to make above mentioned facts by using compass as well as protector in their copy.



2. Researcher should measure each pair of the opposite angles of each cyclic quadrilateral FBGE by GeoGebra and tabulate the measurement in the following table in which researcher used GeoGebra to fill the following table. But students should measure the each angles by using protector software and tabulate the measurement in their copy.

Fig.	<F	<B	<G	<E	<F + <G	<B + <E	Result
i)							<F + <G = 180^o <B + <E = 180^o
ii)							

3. Researcher should ask to students what conclusion was derived. Students should give answer as here, in the cyclic quadrilateral FBGE, <F + <G = 180^o and <B + <E = 180^o. Thus, the sum of the opposite angles of a cyclic quadrilateral is equal to two right angles was main conclusion.

Teaching Episode – 5

Subject: Circle (Exercise)

Duration of lesson: 45 minutes

Target Group: 10^{th}grade (14 – 16 years old)

Teachers: Saroj Devkota

Cooperating teacher: Tirtha Khadka

Date:

I. Prerequisites:

Students are familiar with basic concept about circle such as radius, Centre and circumference as well as have the knowledge of both of above theorems.

II. Required Materials:

Computer, projector, projection screen etc. GeoGebra 5.0 Software is required to be installed in computers.

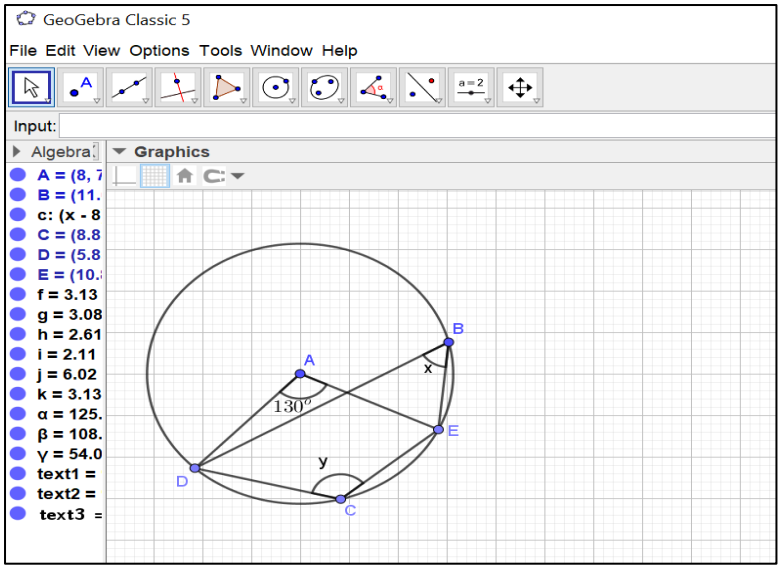
III. Learning Objectives:

- Solve the problem related to the above three theorem

IV. Activities:

Lesson

1. In the beginning, the students are involved in s revision of their pervious learning and activities as well as thinking on relevant questions concerning above three theorem.
2. First of all, researcher makes the alongside figure in GeoGebra window.



3. After demonstrating the figure by projector, students also make the figure in their copy.
4. Researcher interacts with students about finding the value of x and y.
5. Students are involved in the interaction and same time teacher discuss about students point of view towards such type of problems.
6. After that researcher measure the angles x and y by GeoGebra software and he gives reasons behind these unknown angles,
7. After measuring angles in GeoGebra, he demonstrates the all solving process by GGB files.
8. Researcher gives such types of problem to the students by making the figure in GeoGebra window.
9. Students are able to give the answer if they are not able, researcher will provide suitable suggestions for finding the known angles.

Appendix – B

Mathematics Achievement Test in Pre-test

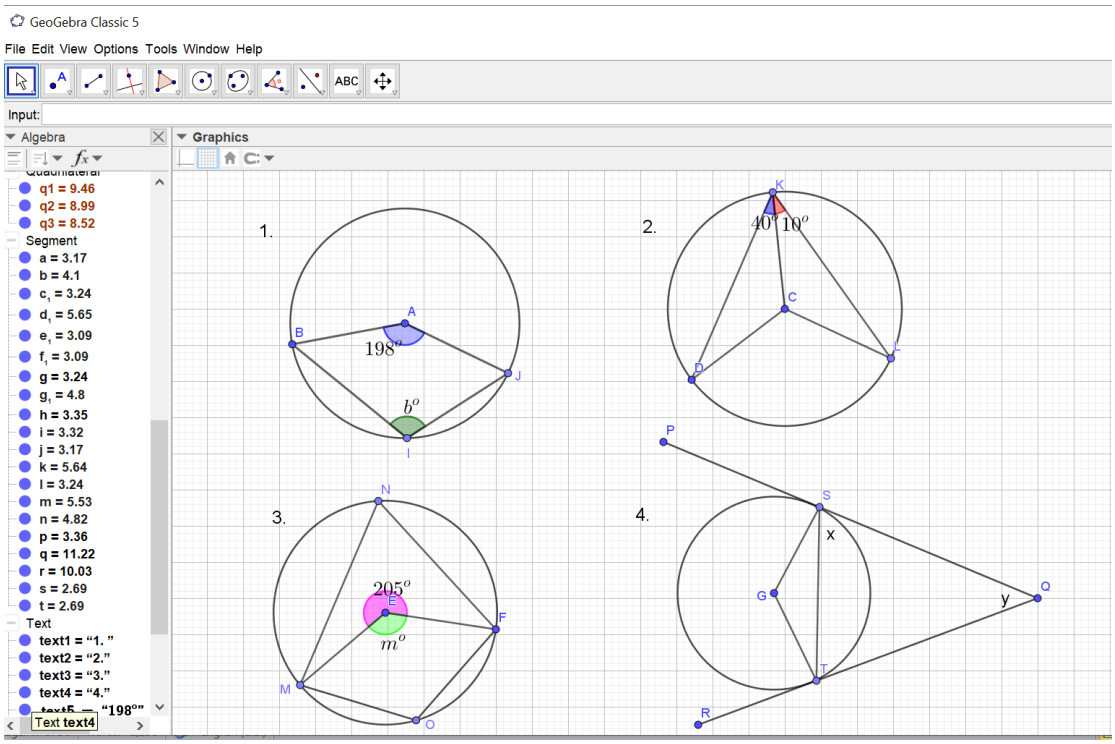
Class – X | Full Marks:- 30

Sub – C. Math's | Pass Marks:- 10

Group A

Attempt all Questions. **[5 × 2 = 10]**

From the following figures, find the value of missing character.



5) Two cords AB and CD of a circle are intersected each other at a point Z inside the circle. If BZ = 12 cm, DZ = 7 cm and CZ = 15 cm, then find the length of AZ.

Group B [5 × 4 = 20]

6) Prove experimental verification of the central angles subtended by equal arcs of a circle are equal.

7) Prove experimental verification of a perpendicular drawn from the centre of a circle to a chord bisects the chord.

8) Prove theoretically of the central angle of a circle is double of the inscribed angle standing on the same arc.

9) Prove theoretically of the equal chords of a circles are equidistant from the centre ofthe circle.

Appendix – C

Mathematics Achievement Test in Post-test

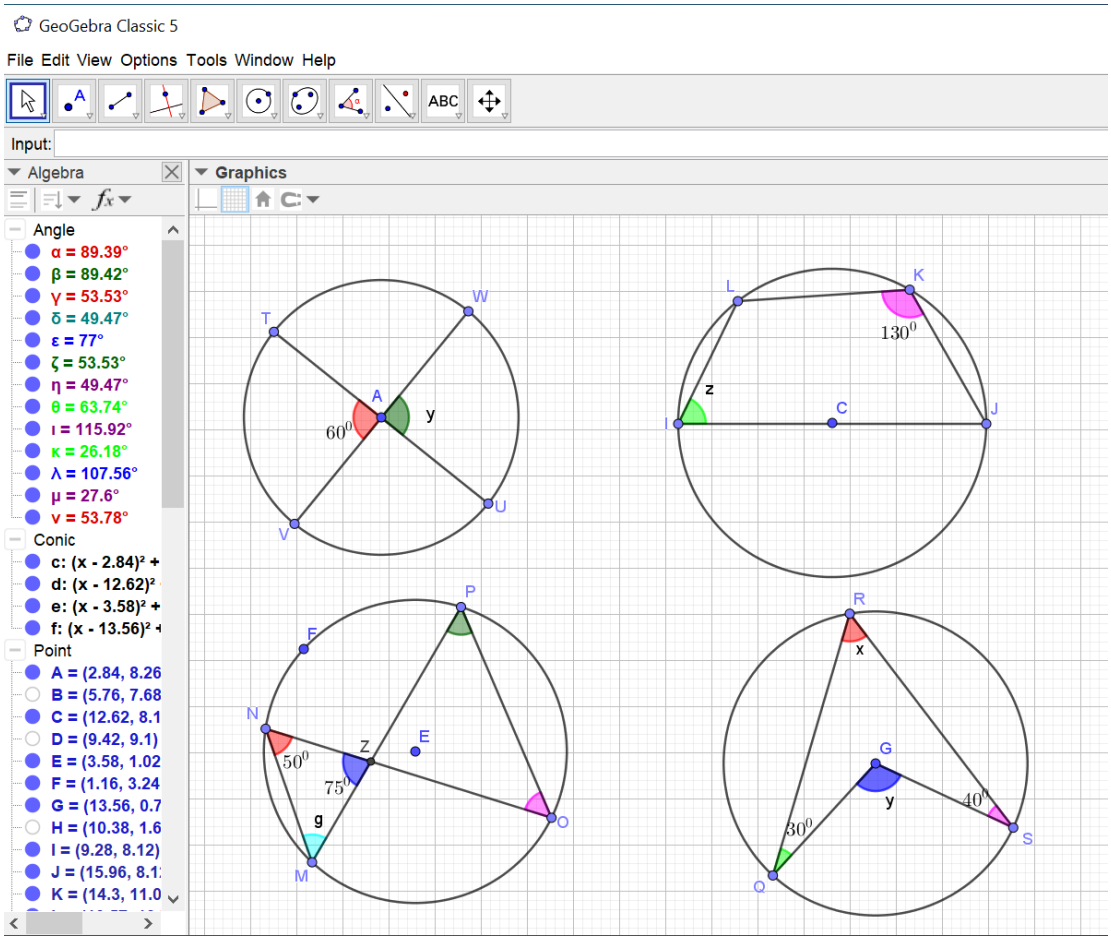
Class:- X | Full Marks:- 30

Sub:- C. Math's | Pass Marks:- 10

Group A [5 × 2 = 10]

Attempt all Questions

From the following figures, then find the value of missing angles.



5) Two chords MN AND OP of a circle are intersected each other at a point Z inside the circle. If NZ = 12 cm, OZ = 6 cm and PZ = 16cm, then find the length of AZ.

Group B [5 × 4 = 20]

6) Prove experimental verification the sum of the opposite angles of cyclic quadrilateral is equal to two right angles.

7) Prove experimental verification of the central angle of a circle is double of the inscribed angle standing on the same arc.

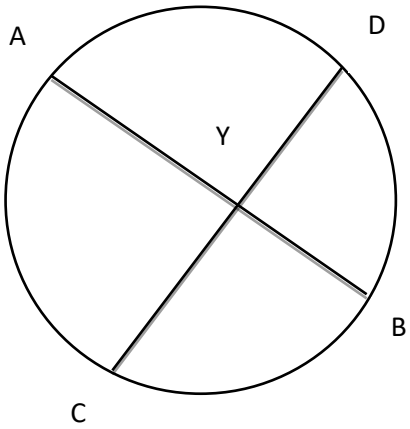
8) Prove experimental verification of a line joining the Centre at a circle and the midpoint of any chord is perpendicular to the chord.

9) Prove theoretically of chord equidistant from the Centre of a circle are equal.

10) In the given circle, two chords AB and CD intersect each other at Y inside the circle,

Prove that:

$<ACY = \frac{1}{2}(\widehat{AC} + \widehat{DB})$



Appendix – D

Item Analysis of the Test

Student / Items	Upper 27% students who giving correct response								Upper 27% students who giving correct response								P (%)	D Value	Remarks
	1	2	3	4	5	6	7	Total	1	2	3	4	5	6	7	Total			
1	1	1	0	1	1	1	1	6	1	0	1	1	0	1	1	5	78.57	0.14	
	1	1	1	0	1	1	0	5	1	0	1	0	0	1	1	4	64.29	0.14	
																		0.14	
2	1	1	1	1	0	1	1	6	0	0	0	0	1	0	1	4	71.43	0.29	
	1	0	1	0	1	0	1	4	0	0	0	0	1	0	1	4	57.14	0	
3	1	1	1	1	1	1	1	7	1	0	1	0	1	1	1	5	85.71	0.29	
	1	1	1	1	1	1	1	7	1	0	1	0	1	1	1	5	57.14	0.29	
																		0.29	
4	1	1	1	1	0	1	1	6	1	0	0	1	0	0	0	2	57.14	0.57	
	1	0	1	1	1	1	1	6	1	0	0	1	0	0	0	2	57.14	0.57	
																	57.14	0.57	
5	1	1	1	0	1	0	1	5	1	1	0	0	1	1	0	3	57.14	0.57	
	1	0	1	0	1	1	0	4	1	0	1	0	1	1	0	3	50	0.14	
6	1	1	0	1	0	1	0	4	1	0	1	0	1	0	0	3	50	0.14	
	1	1	0	1	0	1	0	4	0	1	0	0	1	0	0	2	42.86	0.57	
7	1	1	1	0	1	1	1	6	1	1	0	0	1	1	0	4	71.43	0.57	

	1	1	1	0	1	1	1	6	1	1	0	0	1	1	0	4	71.43	0.57	
																	71.43	0.57	
8	0	1	1	1	0	1	1	5	1	0	0	0	1	0	0	2	50	0.43	
	0	1	0	1	0	1	1	4	1	0	0	0	0	0	0	1	35.71	0.43	
																		0.43	
9	1	1	1	1	1	1	1	7	1	1	0	0	1	0	1	4	78.57	0.43	
	1	1	1	1	1	1	1	7	1	1	0	0	1	0	1	4	78.57	0.43	
																	78.57	0.43	
10	1	0	0	1	0	0	1	3	0	1	0	0	0	1	0	2	35.71	0.14	
	1	0	0	1	0	0	1	3	0	1	0	0	0	1	0	2	35.71	0.14	
	1	0	0	1	0	0	1	3	0	1	0	0	0	1	0	2	35.71	0.14	
	1	0	0	1	0	0	1	3	0	1	0	0	0	1	0	2	35.71	0.14	
																	35.71	0.14	
11	1	1	1	0	1	1	1	6	1	0	1	0	0	0	0	2	57.14	0.57	
	1	1	1	0	1	1	1	6	1	0	1	0	0	0	0	2	57.14	0.57	
	1	1	0	0	1	1	1	5	0	0	0	1	0	0	0	1	42.86	0.57	
	1	1	0	0	1	1	1	5	0	0	0	1	0	0	0	1	42.86	0.57	
																		0.57	
12	1	1	0	1	1	0	1	5	1	0	0	0	0	0	0	1	42.86	0.57	
	1	1	0	1	1	0	1	5	0	0	1	0	0	0	0	1	42.86	0.57	
	1	1	0	1	1	1	1	6	0	0	0	0	0	0	0	0	42.86	0.87	
	1	1	0	1	1	1	1	6	0	0	0	0	0	0	0	0	42.86	0.86	
																	42.86		
13	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	1	21.43	0.14	

	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	1	21.43	0.14	
	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	1	21.43	0.14	
	1	0	1	0	0	0	0	2	1	0	0	0	0	0	0	1	21.43	0.14	
																	21.43	0.14	
14	1	1	0	0	1	1	1	5	1	0	0	0	0	1	0	2	50	0.43	
	1	1	0	0	1	1	1	5	1	0	0	0	0	1	0	2	50	0.43	
	0	0	1	1	1	1	0	4	0	1	0	0	0	0	0	1	35.71	0.43	
	0	0	1	1	1	1	0	4	0	1	0	0	0	0	0	1	35.71	0.43	
																		0.43	
15	1	1	1	1	1	1	1	7	0	0	0	0	0	0	0	0	50	1	
	0	1	1	1	1	1	1	6	0	0	0	0	0	0	0	0	42.86	0.86	
	1	0	1	0	1	1	1	5	0	0	1	0	0	0	0	1	42.86	0.57	
	1	0	0	1	0	1	1	4	0	0	0	0	0	0	0	0	28.57	0.57	

Appendix – E

Reliability of the Achievement Test

S.N.	Scores on Odd Items (X)	Scores on Even Items (Y)	X^2	Y^2	XY
1	15	19	225	361	285
2	20	15	400	225	300
3	14	17	196	289	238
4	22	21	484	441	462
5	15	16	225	256	240
6	24	19	576	361	456
7	17	23	289	529	391
8	7	13	49	169	91
9	5	5	25	25	25
10	8	7	64	49	56
11	3	11	9	121	33
12	6	8	36	64	48
13	7	7	49	49	49
14	6	8	36	64	48
Total	$\sum X$ = 169	$\sum Y$ = 189	$\sum X^2$ = 2663	$\sum Y^2$ = 3003	$\sum XY$ = 2722

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

$$= \frac{14 \times 2722 - 169 \times 189}{\sqrt{14 \times 2663 - (169)^2}\sqrt{14 \times 3003 - (189)^2}}$$

$$= 0.83$$

Reliability Coefficient (r) = $\frac{2 r_{xy}}{1 + r_{xy}} = \frac{2 \times 0.83}{1 + 0.83} = 0.91$

Appendix – F

Score of Pretest

S.N.	Scores of Students in ExperimentalGroup	Scores of Students in ControlGroup
1	26	28
2	23	20
3	19	21
4	20	16
5	21	20
6	19	15
7	15	18
8	8	6
9	12	14
10	16	12
11	22	20
12	25	18
13	6	11
14	16	20
15	23	18
16	26	22
17	20	19
18	17	20
19	19	24
20	11	15
21	18	23
22	26	25
23	24	21
24	14	16
25	21	19
26	18	
27	22	
28	23	
	$\bar{x}$ = 18.93, S_1^2 = 26.85, S_1 = 5.18	$\bar{x}$ = 18.44, S_2^2 = 21.28, S_2 = 4.61

Appendix – G

Score of Posttest

S.N.	Scores of Students in ExperimentalGroup	Scores of Students in ControlGroup
1	29	28
2	27	22
3	22	25
4	23	20
5	22	22
6	21	23
7	20	22
8	15	11
9	17	20
10	19	21
11	26	24
12	28	20
13	11	17
14	18	23
15	25	19
16	29	25
17	24	21
18	20	22
19	23	24
20	18	19
21	22	25
22	28	27
23	26	23
24	117	18
25	25	20
26	20	
27	25	
28	27	
	$\bar{x}$ = 25.96, S_1^2 = 26.85, S_1 = 5.18	$\bar{x}$ = 21.64, S_2^2 = 11.75, S_2 = 3.43

Appendix – H

Mathematics Perception Scale

S.N.	Items	SD	D	UD	A	SA
1.	I like to use GeoGebra Software.					
2.	GeoGebra Software helps to learn Mathematics concepts.					
3.	I feel confident when the activities do by using GeoGebra Software.					
4.	I learnt a lot about Mathematics when using GeoGebra Software.					
5.	I can think creatively and critically when using GeoGebra Software.					
6.	I prefer to learn Mathematics with GeoGebra Software.					
7.	GeoGebra Software can help to increase my achievement in Mathematics.					
8.	I am excited when asked to explore the GeoGebra Software.					
9.	I am happy if the teacher uses the GeoGebra Software in teaching Mathematics.					

Appendix – I

Statistical Formula Used in Data Collection and Analysis Procedure

S.N.	Subject	Notation	Formula
1	Mean	$\bar{x}$	$\frac{\sum x}{N}$
2	Variance	S^2	$\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)^2$
3	Combine Variance	S_{P^2}	$\frac{(n_1-1)S_{1^2} + (n_2-1)S_{2^2}}{n_1 + n_2 - 2}$
4	Standard Deviation	S	$\sqrt{\frac{\sum x^2}{N} - \left(\frac{\sum x}{N}\right)^2}$
5	Pearson's Correlation Coefficient	r_{xy}	$\frac{N\sum XY - \sum X \,.\, \sum Y}{\sqrt{N\sum X^2 - (\sum X)^2}\sqrt{N\sum Y^2 - (\sum Y)^2}}$
6	Difficulty Level of Items	P %	$\left(\frac{R_u + R_l}{N} \times 100\right)\%$
7	Discrimination Index of Item	D	$\left(\frac{R_u + R_l}{\frac{N}{2}}\right)$, where R_u and R_l are the number of correct response given by upper 27% and lower 27% students respectively. N is the total number of lower 27% students plus total number of upper 27% students.
8	Reliability Coefficient	r_{tt}	$\frac{2\, r_{xy}}{1 + r_{xy}}$
9	F – Distribution	F	$\frac{S_1{}^2}{S_2{}^2}$