EFFECTIVENESS OF GEOGEBRA IN TEACHING MATHEMATICS

A

THESIS

BY

DIP NARAYAN MAHATO

FOR THE PARTIAL FULFILMENT OF REQUIREMENTS OF FOURTH SEMESTER FOR THE DEGREE OF MASTER OF EDUCATION IN MATHEMATICS EDUCATION

SUBMITTED

TO

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Letter of Certificate

This is to certify that **Mr. Dip Narayan Mahato**, a student of academic year **2070/071** with Campus Roll No: **319,** Exams Roll No: **280421,** T.U. Registration No: **9-2-263-371-2008** and Thesis No**: 1334** has completed his thesis under my supervision for the period prescribed by the rules and regulations of T.U., Nepal. The thesis entitled '**Effectiveness of Geogebra in Teaching Mathematics**'' embodies the result of his investigation conducting the period of 2019 under the Department of Mathematics Education, University Campus, T.U., Kirtipur. I, hereby, recommend and forward that his thesis be submitted for the evaluation as the partial requirements to award the degree of Master of Education in Mathematics Education.

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Assoc. Prof. Laxmi Narayan Yadav

(Head of the Department)

December 19, 2019(Paush 3, 2076)

Letter of Approval

This thesis entitled "**Effectiveness of Geogebra in Teaching Mathematics**" submitted by **Dip Narayan Mahato** for the partial fulfillment of requirements for the degree of Master of Education in Mathematics Education has been approved.

Committee for the viva- voce	**Signature**
1. Assoc. Prof. Laxmi Narayan Yadav (Chairperson)	……
2. Prof. Uma Nath Pandey (External)	……..
3. Mr.Abatar Subedi (Supervisor)	…….

September 19, 2019(Poush 3, 2076)

Recommendation for Acceptance

This is to certify that **Mr. Dip Narayan Mahato** has completed his M.Ed. thesis entitled "**Effectiveness of Geogebra in Teaching Mathematics**" under my supervision during the period prescribed the rules and regulations of Tribhuvan University, Kirtipur. I recommend and forward his thesis to the Department of Mathematics Education to organize the final viva – voce.

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Mr.Abatar Subedi

(Supervisor)

Date: September 19, 2019(Paush 3, 2076)

Defensed Date: December 19, 2019

Dedication

This thesis is dedicated to my loving parents Mr.Jagdev Mahato and Mrs. Binda Mahato who inspired, encouraged, supported and motivated me to walk on the path of educational journey.

Declaration

I, hereby, declare that this thesis has not been submitted for the candidate for any other degree.

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Dip Narayan Mahato

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Abstract

This study entitled on 'Effectiveness of Geogebra in Teaching Mathematics' conducted with the specific objectives that to compare the student's achievements taught by usin ggeogebra and taught without using geogebra in teaching mathematics and to investigate the student's perceptions towards geogebra in learning mathematics at a secondary level. This study was based on the non equivalent experimental research design on the theoretical basis of Vygotsky's social constructivism.

One school with 20 students and another with 20 students for experimental and control groups respectively. The students of the experimental group were taught by using geogebra whereas the students of control group were taught by traditional method. The data were collected mathematics achievement test, class observation note and likert's scale. The pilot study was conducted to ensure the validity and reliability of the test. For the validation of the tools were by mathematics curriculum and expert judgment. The collected data were analyzed by descriptive mean and standard deviation and inferential t –test statistical techniques. The finding of the study indicated that students in the experimental group performed significantly better than the students in the control group. Also, the students perceptions towards the using geogebra is positive .The study found that the students taught by geogebra were more motivated regularly participated, cooperated and positive attitudes, interactive and positive perceptions towards teaching and learning mathematics. Therefore, Geogebra is found to be is very effective tool on teaching and learning mathematics over traditional methods.

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List of the Acronyms

ICT	:	Information, Communication and Technology
NASA	:	National Assessment for Students Achievement
NCTM	:	National Council for Teachers of Mathematics
ZPD	:	Zone of Proximal Development
NCF	:	National Curriculum Framework
MKO	:	More Knowledge Other
NSSS	:	Nav Shanti Secondary School
SSSS	:	Super Sense Secondary School
SD	:	Standard Deviation
CW	:	Class Work
HW	:	Homework

Chapter I

Introduction

This chapter deals with the background of the study, statement of the problem and significance of the study .Similarly, it also mentions about the research objectives, research questions and delimitations of the study. Furthermore, definitions of the key terms are also provided to capture the main components of the study.

Background of the Study

During the past decade, a great deal of literature has been produced on the use of Information, Communication and Technology (ICT) in schools. The ICT refers to the hardware, software, networks and media for the collection, storage, processing, transmission and presentation of information as well as related services describe the extent of the uses of ICTs in the following terms: Information and communication technology are broadly defined as technologies used to convey, manipulate and store data by electronic means. This can include e-mail, text messaging, video chat, and online social media. It also includes all the different computing devices that carry out a wide range of communication and information functions. All these electronic tools constitute the ICTs and are used to convey, manipulate and store information.

Government of Nepal is promoting to use ICT in education sector for quality education. ICT in Education Master Plan (2013-2017) introduces the ICT in education. Ministry of Education is on-going implementation of its ICT Master Plan that is aimed at improving the speed of internal communication and staff access to essential working documents and information, it focuses on four main components infrastructure, manpower, digital contents and system enhancement. ICT in School Directives (2069) has mentioned the use of ICT tools in decreasing the gap of

education quality that exists between private and community schools, urban and rural schools.

SSRP has focused on ICT tools will be applied as a mechanism to meet the specific learning needs of target groups (M0E, 2009). National Curriculum Framework has urged to include the ICT Education in school curriculum as a specific subject. It further highlights the use of ICT as subject and tools/medium in developing the curriculum for educational transformation (CDC, 2063). The IT Policy (2067) and Three Year Plan (2011-2013) of the Government of Nepal have included some policies and strategies in order to develop & integrate ICT in education.

ICT in education has multiplier effect throughout education system by enhancing learning and providing students with new set of skills (UIS, 2014).Many teachers and students believe that ICT can make effective to the teaching-learning use ICT in education. There is lack of physical infrastructure, manpower, digital content and teacher's willingness. This study mainly focuses on teacher's and student's readiness to use ICT as a tool in teaching learning process. Digital technologies are available in school mathematics classrooms since the introduction of simple four-function calculators in the 1970s. From that time, computers equipped with increasingly sophisticated software, graphics calculators that have morphed into all-purpose hand-held devices integrating graphical, symbolic manipulation, statistical and dynamic geometry packages and web-based applications offering virtual learning environments have changed the mathematics teaching and learning area. This presentation considers the extent to which technology-related research, policy and practices might usefully inform each other in supporting effective mathematics teaching and learning in Nepal's schools. Mathematics evidently can be defined as the science of numbers, quantity and space of which arithmetic, algebra, trigonometry and

geometry are branches [Oxford Dictionary]. So, mathematics serves as bedrock for other science subjects and at the same time, strengthens and sharpens the intellectual skills of students. Mathematics is a very important subject. Remarked “mathematics is the backbone of knowledge” (Ale, 1981). It is also described as the pivot of all civilizations and technological development. These descriptions point the important position accorded to mathematics as a key factor in the development of any nation. Nepalese educational system is rapidly developing due to the technological growth of the nation. Regarding this view , the New National Policy of Education stipulates that mathematics should be one of the core subject taught at all levels of secondary and primary schools since the importance of mathematics cannot be over emphasized in the area of science and technology. Thus, mathematics is a compulsory subject for all primary and secondary schools in many countries of the world.

Statement of the Problem

Mathematics is taken as a compulsory subject in school education. The result of mathematic is comparatively poor than other subjects in government secondary schools. It is fact that the mathematics teaching and learning in Nepalese schools is often focused on memorization of facts and formulae. Learners also showed lack of mathematics problem solving skills and higher order thinking skills, which cannot be easily developed in memorization of facts and formulae. The learners feel hard to understand mathematics by teaching traditional methods. According to NASA reports, 2011 and 2013 the average scores of students are 43 and 35 respectively. Similarly, by the reports 2012 and 2015, the average scores of class 3 students are 60 and 45 respectively. Likewise, by the reports 2012 and 2015, the average scores of class 5 students are 53 and 48 respectively in mathematics. In these above reports the subjective average achievements were not satisfactory. On the other hand, the results of SEE students are not satisfactory in optional and compulsory mathematics. In the context of Nepal maximum mathematics teachers are unknown about geogebra software and they are also unknown about the perception of students on the use of geogebra in mathematics teaching,

Objectives of the Study

The objectives of this study were able to compare the student's achievements taught by geogebra and by traditional method in mathematics and also to investigate the student's perceptions towards geogebra.The objectives of the study were:

- To compare the achievements of students taught by GeoGebra and by traditional method.
- To investigate the student's perceptions towards GeoGebra.

Research Questions

This whole study indented to find out the answers of the following questions:

- What are the differences between the achievement of students taught by GeoGebra and by traditional method?
- What are the student's perceptions towards GeoGebra?

Hypothesis of the Study

Hypothesis is a conjectural statement of the relationship between two or more variables (Kerlinger, 1986:17). The researcher had prepared the following hypotheses:

Research Hypothesis: Research hypothesis is tentative statement about the expected outcomes for the variables in the study. The research hypothesis was:

- The use of geogbra enhances the student's achievement over the traditional method.

Statistical Hypothesis: The null and alternative hypotheses were given below:

- H_O : There is no statistically significant difference between the mean score of achievement taught by GeoGebra and traditional method on posttest i.e.H_0:$\mu_1=\mu_2$ (Null Hypothesis).
- H_1: There is statistically significant difference between the mean score of achievement of experimental group is higher over the control group on post test.i.e.H_1:$\mu_1>\mu_2$ (Alternative Hypothesis).

Where, μ_1= mean scores of experimental group and μ_2= mean of control group.

Significance of the Study

The significances of this study were:

- This study would be helpful to mathematics teachers for using geogebra in mathematics classrooms.
- This study would be useful for educational policy makers, educational administrators, curriculum developers and educational planners to suggest effective use of geogebra in mathematics teaching and learning.
- This study would be supported as a reference material to the concerned researcher students.
- This study would help the counselors to provide the positive attitudes toward geogebra.
- It would introduce a new pedagogy in existing educational system.
- It would investigate the students and teachers the beliefs, feeling, attitudes, motivation and perceptions towards the use of geogebra in mathematics.

Delimitations of the Study

This current study delimited by the following points:

- This study was conducted only in the chapter of matrix of optional mathematics of grade X.
- The study was delimited with achievement test, student's perceptions and classroom observation note.
- This sample of this study was delimited in only two private secondary schools of Dhanusha district.
- This study was conducted only two weeks with period of 45 minutes.

- It was based on experimental method under quantitative method design.

Operational Definitions of the Key Terms

Effectiveness: It is defined in term of change of scores, change in attitudes, change in motivation, change in perceptions and change in participation and regularity of students. Similarly, change in behavior on mathematics. Moreover, in this study, effectiveness means increases the student's achievements in mathematic sand also increases the student's perceptions towards using geogebra in teaching mathematics.

GeoGebra: Geogebra is an interactive, free, multi platform, open source dynamic mathematics software suitable for teaching and learning mathematics on geometry, algebra and calculus.

Traditional Method: The researcher teaches the lesson by lecture method and in this method teacher plays the active role to conduct the lesson and students listen passively to the teacher.

Achievement Test: In this research, mathematics achievement test constructed by the researcher and administrated to the students based on the mathematics curriculum.

Experimental Group: The group which is given the treatment is called experimental group. In this study, a group of students of Shree Nava Shanti Secondary School of grade X to whom the researcher teaches the matrix using GeoGebra is considered as an experimental group.

Control Group: The group which is not given the treatment is called control group. In this study, a group of students of Shree Super Sense Secondary School of grade X to whom the researcher teaches the same unit without using GeoGebrais considered as control group.

Perception: Perception is the organization, identification and interpretation of sensory information in order to represent and understand the environment (Encyclopaedia). But in this study perception represents knowledge, experience, concepts and comprehension about of use of GeoGebra.

Chapter II

Review of Related Literature and Conceptual Framework

This chapter focuses on the meaning of literature review, the review of related empirical Literature review, theoretical and conceptual frameworks and the implications of the review for the study. In terms of literature review, literature means works which consulted in order to understand and investigate the research problem. Review means a process of systematic, particular and critical summary of the published literature in the area of research. Therefore, literature review is an essential part of all research works. When topic of research has been selected, it is essential to the researcher to review all relevant materials about the selected topic. Review of the literature started with a search for suitable topic and continues throughout the duration of the research work. A literature review is very important stage of research studies. Review of the literature is the process of learning and understanding the concept of related topic. It is the method to find out the previously done research and utilizing the relevant fact into own problem for a concrete findings. “A literature review is the process of locating, obtaining, reading and evaluating the research literature in the area of your interest (Haywood and Wagg, 1982).

Review of the Empirical Literature

Moila (2006) did a research on, “The use of educational technology in mathematics teaching and learning: An investigation of South Africa rural secondary school”. The investigation followed a mixed method approach that was more evaluative and was a case study. The study consisted of 25 students and 5 mathematics teachers from Phusela secondary school. The finding concluded that the computer technology was not used in mathematics teaching and learning, there are no plans on the use of educational technology tools in mathematics teaching and

learning, inadequate educators training on the use of educational technologies in teaching and mathematics and lack of relevant educational technology tools for rural schools.

Keong, Horani and Dainiel (2005) did a research study on the use of ICT in mathematics teaching in Malaysia. This research deployed a survey method to investigate the use of ICT and barriers of integrating ICT into the teaching of mathematics. The survey was carried out during mathematics in service course conducted by State Education Department. The findings concluded that the of ICT in teaching mathematics can make the teaching process more effective as well as enhance the students' capabilities in understanding basic concepts.

Clacke (2007) carried out a research article on" Exploring the use of computer technology in Caribbean content: view of pre –service teachers". This article presents a qualitative study of five pre – service school mathematics teachers in English speaking in Caribbean context. The major goal of this study was to investigate the experiences and perceptions of the PSSM teachers as they explored the use of computer technology in their mathematics instructional practices and to identify factors they considered necessary for successful integration of ICT in mathematics instruction.

Rendell (2001) was concerned recognizing the effectiveness of ICT assisted teaching for mathematical in algebra and geometry topics invest learning programs for rural public school student. The 80 students of the control group studies over three semesters using traditional methods ,while the experimental group comprised 40 students who studies using ICT assisted method .The study indicated that ICT assisted teaching was more effective in raising the arithmetical and logical skills in mathematical compared with traditional methods.

Mawata (1998) studied the effect of ICT on the achievement among high school student and their attitudes toward mathematics .For this purpose, the researcher prepared a series of lessons related to conversions' engineering by teacher who were teaching this coursework .Additionally, he undertook teacher training on developing java applet software and using java language, to make learning from web pages more interactive. The study sample consisted of 163 students enrolled in three high schools within Baltimore, USA. The finding indicated that the students' achievement was high according to the achievement. Furthermore, the finding indicated the presence of a positive growth in attitudes towards from the study sample.

Cox (1997) studied elementary and secondary school students' use of technology and their attitudes towards ICT. The study was grounded in an analysis of the literature relating to motivation as it indicates that the regular use of ICT for various topics can have a stimulating and beneficial effect on students' learning. students 'responses showed their increasing commitment to the learning task, enforcing enjoyment ,benefit and feeling of achievement in learning when using ICT and emphasizing their self- esteem. Over 75% of secondary school students stated the response 'I agree or I strongly agree.' to the statement that the use of computers made the school subjects more exciting. Also, over 50% of the students showed agreement that the use of ICT helped them understand their topics in a better manner.

Barve & Barve (2012) did a research on" Role of technology in teaching-learning mathematics". This paper reports finding of the study though teachers know the general advantages of ICT use, many mathematics teachers are unaware of the potential of specific software and tools. It is observed that very little use of appropriate ICT tools is made in mathematics teaching. Good teaching using ICT begins with clarity of purpose in its use. Most often this comes with experience and

through planning and collaboration between teachers integrating ICT into a scheme of work. Less successful use of ICT in core subject teaching typically stems from weak links between the computer task and the lesson objectives. If we deliver training with clarity of purpose and proper ICT support, considering the requirements of teachers are able to start the use of ICT in their teaching

Martin (2016) did research on "Information communication technology pedagogical integration in mathematics instruction among teachers in secondary schools in Kenya". This paper reports finding of the study that sought to ascertain the extent of ICT-pedagogical integration in mathematics instruction among secondary school teachers in Kenya. Information was sought on professional development experiences and needs in computer technology use in mathematics instruction, the type of computer software used in mathematics curriculum content delivery, the influence of accessibility to ICT infrastructure and technical support, teachers' competence and confidence on ICT integration in mathematics teaching and learning. . That is the more the teacher feels at ease, liking and confident, the easier he or she feels the need to use ICT tools as an instructional tool.

Shadan and Eu (2013) conducted a study entitled effectiveness of use of geogebra on students understanding in learning circles in order to investigate the effectiveness of using geogebra in the learning circles. A quasi experimental design with pre-test and post test have been completed to control and experimental groups considering 9 years students in Selangor. Their finding indicates that use geogebra in learning circles had positive impacts on students positive understanding. This study established geogebra as an effective tool for teaching circles focusing students understanding .Furthermore, technology has become a motivational tool in learning

circles. Thus, use of geogebra in geometric construction may be beneficial to both teachers and students in geometric construction.

Sapkota (2015) did a research on" Effectiveness of ICT integrated pedagogy at secondary level". With the aim to find the effectiveness of ICT integrated pedagogy in the existing educational system among students in the experimental and control group of grade 9. 46 students of two public secondary schools of Kathmandu district were selected for the study. She conducted that ICTIP bring the effective result in terms of the achievement of mathematics in comparison to the existing pedagogy as well as students taught by ICTIP are more motivated towards mathematics instruction.

Shrestha (2015) did a research on status of ICT use in teaching /learning mathematics .The objective of the study was to investigate the use of ICT in mathematics teaching and learning .In order to achieve the objective, a school by the name Heartland Children's Academy from Kathmandu district was visited for week long to conduct the study using case study design. Participants were sampled mathematics students and teachers of that school. She was used to collect the major tools like observation and interview. Three teacher and twenty students from classes 7, 8, 9 and 10 were considered as the sample of the study. It was found from the study that there were neither any plans on the use of educational technology tools in mathematics teaching nor learning nor adequate teachers training on the use of educational technologies. The major findings of this study were lack of relevant technology for school. There were the main reasons for the schools not to use the educational technology tools in mathematics teaching and learning. However, these tools were sometimes used for other purpose other than mathematics leaching and learning.

Paudel (2015) did a research on the topic teachers' and students 'perceptions on the use of ICT in mathematics" .The study investigates was the perceptions of teachers and students who uses ICT in mathematics classroom. The purpose of this study was to know the perceptions towards mathematics after using ICT in mathematics classroom of students as well as teachers. How did student and teacher think or perceived mathematics as a subject? The researcher generated two questions to identify the perceptions of students and teachers towards the use of ICT in mathematics. He used interpretive as his research paradigm. He also used open – ended questions in –depth interview to explore the views from the participants to know their perceptions towards mathematics after using ICT in mathematics. The major findings of the study are by the use of ICT in mathematics classroom the student felt mathematics as other subjects. Before using ICT perception towards mathematics was a boring and harder subject and the student couldn't concentrate well in the class but after using ICT the perception towards mathematics is changed .ICT helped to bring positive perception towards mathematics and students started to study and learnt by understanding their meaning and felt mathematics as a normal subject like other thus, the schools should start realize the need of for student through the help of perfect information, proper communication and modern technologies.

Bhandari (2015) conducted a study entitled 'Effectiveness of geogebra assisted instruction in mathematics at secondary level'. The data were collected from 48 students from two public schools in Kathmandu using quasi experiment design by the way of test items and questionnaires. The reliability of these tools was ensured through Split-half method. The result shows that GeoGebra assisted instruction improves the students achievements in mathematics in the comparison of subsisting pedagogy.

Theoretical Framework of the Study

Social constructivist theory was developed by LevVygotsky. According to Vygotsky, learning by the child occurs through social interaction with a skilful tutor. The tutor may model behaviors and provide verbal instructions for the child. Vygotsky refers to this as co-operative or collaborative dialogue. The child seeks to understand the actions or instructions provided by the tutor or parent or teacher then internalize the information, using it to guide or regulate their own performance. Vygotsky also views interaction with peers as an effective way of developing skills and strategies. He suggests that teachers use cooperative learning exercises less competent children develop with help from more skilful peers - within the zone of proximal development (Jabara, 2011).The key concepts in the theory of social constructivism are ZPD (Zone of Proximal Development), MKO (More Knowledgeable Other) and Scaffolding. The more knowledgeable other (MKO) refers to someone who has a better understanding or a higher ability level than the learners, with respect to a particular task, process, or concept. The ideal role of the teacher is that of providing scaffolding (support) to assist students on tasks within their zones of proximal development. The role of MKO is “scaffolding”, in which he or she plays the role of a facilitator or a guide. Scaffolding is a concept closely related to the idea of ZPD. Scaffolding is changing the level of support. Over the course of a teaching session, a more skilled person adjusts the amount of guidance to fit the child’s current performance (Sharma & Sharma, 2066).This study here is frame by two elements of scaffolding the first one is sharing a specific goal which is the teacher’s responsibility to establish the shared goal. However, the learner’s interests must be recruited or enlisted through the teacher’s ability to communicate with the learner and content.

The teacher must be considerate of some of the unique, unusual and often infective problem solving techniques that children use.

The second one is immediate availability of help which deals frequent success in important in scaffolding especially in helping control frustration level of the learner. Student successes may be experience more often if the MKOprovide assistance in timely and effective manner so as to enable the learner to proceed with the task. It helps to increase motivation through a positive self-efficiency and make the learner's time and effort more productive. Vygotsky'ssocial constructivism is essential tool for collaborative teaching learning in which student's and teacher both are actively engage in teaching learning procedure. In this sense my research is directly related Vygotsky's social constructivism because teacher having more academic degree has more knowledge then lower degree that can provide more instruction for strengthen student's achievement (Sharma &Sharma, 2066).

Social constructivism is highly effective methods of teaching that all students can get from it, since collaboration and social interaction are incorporated. This type of constructivism was formed after Piaget has already described his theory about individual or cognitive constructivism. Social constructivism depends on Vygotsky's theory .Lev Vygotsky is the founding father of this theory based on the social interactions with students in the classroom along with a person critical thinking process. According to this theory, interaction is prominent to develop effective classrooms. Zone of Proximal Development (ZPD) is the main component of the theory. He states that learning occurs with a zone of proximal development which is the distance between a learner's actual development level as determined by independent problem solving and his /her potential development with guidance form "a capable other" or in collaboration with "more capable peers".

Social constructivism is defined as a process by which students make meanings and the central role of their community through culture and language. Learning is seen as a social and collaboration activity that is facilitated rather than directly taught by the teacher. This theory focuses that in the classroom, every student should be active participants and to interact each other. In the context of learning knowledge ,role of teacher, role of student ,role of school and learning environment on the base of social constructivism. The students have also actively engaging in the process of scaffolding as they sought assistance from more advanced students in their mathematics classrooms by ICT assisted instruction. Knowledge is not transformed to high educators to the low educators rather knowledge can be constructed learners themselves is the main motto of this theory (Acharya, 2017).

Implications of the Review for the Research

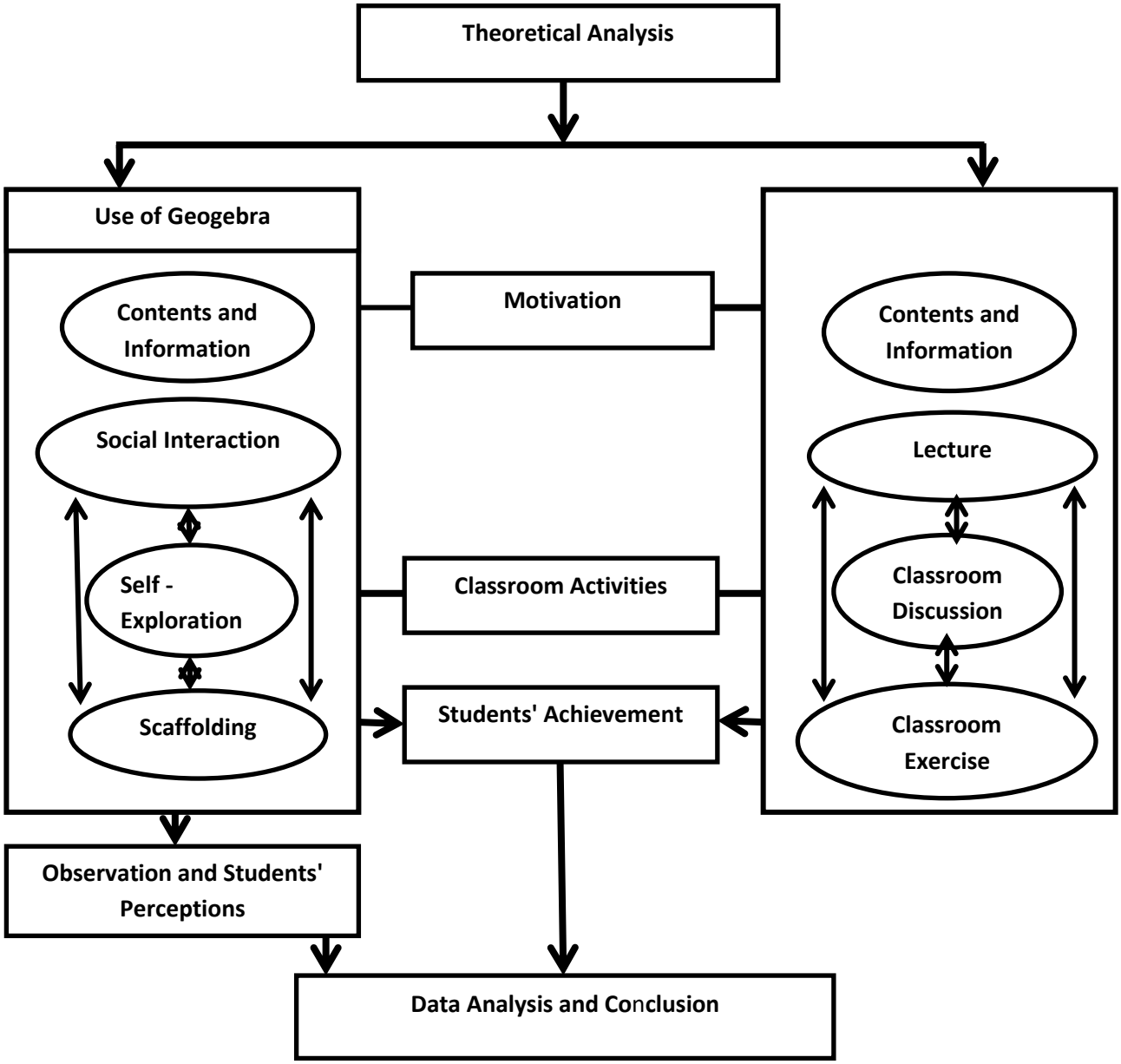
There are various implications of the review for the research. When the researcher increases the knowledge after study the review of the related literature and theoretical literature then it enables to analyze and interpret the collected data. Theoretically, in this study, the Lev Vgotsky's constructivist theory helps to provide guidance to do the research study easily. This theory also helps to give the findings and conclusions of this study. Some of the researches are related to teaching mathematics in the classrooms and others are related to activities, methods use in different genres of mathematics. Among them, I have selected and reviewed some of the researcher's works. I got a lot of ideas about the research designs, methodologies and procedures. Especially, many studies helped to broaden my knowledge while selecting research designs and preparing tools for data collection. Similarly, they provided an insight to developing the conceptual framework for the study. The review of related literature made the researcher feel the necessity to carry out this study.

Similarly, the entire reviews help the researcher to be familiar with the research procedures and research format to be followed while carrying out the research. Moreover, the reviewed literature has become beneficial to develop research tools and bring clarity in methodologies. To sum up, aforementioned studies have significant values to make this study systematically and scientifically and validate the findings of the study.

Conceptual Framework for the Study

The conceptual framework tries to clarify the study of the variables (dependent and independent) draw from the research based literature and theory based knowledge to fulfill the objectives. Vygotsky's view is closely related to the learning environment and emphasizes the theme that the social interaction and the cultural environment contributes the cognitive development of the child .Moreover, the whole study had concerned the following framework:

Figure 1: Conceptual Framework of the Study



(Source: Kandel, 2018)

Chapter III

Methods and Procedures

This chapter deals with the research design of the study, population and sample of the study, tools of the study, data collection procedures, data analysis procedures and ethical considerations which are described as follows:

Research Design and Method of the Study

Research design is a pre planned strategy to achieve the objectives of the study. It provides a proper guidance to do the research work. It is the detailed plan of the investigation .In fact; it is the blueprint of the detailed procedures of obtaining and analyzing the data (Sing, 2008). This study was based on experimental method under quantitative method.

Table 1: Research Design of the Study

Groups	Pre- test	Treatment	Post- test
Experimental Group	T_1	Teaching with GeoGebra	T_2
Control Group	T_1	Teaching without GeoGebra	T_2

Where,

T1=Pre-test given to the students of experimental and control groups and

T_2=Post- test given to the students of experimental and control groups.

Population, Sample and Sampling Strategy of the Study

The population of the study was all the students of private schools of grade X studying in Dhanusha district. The researcher selected two secondary schools of Dhanusha district namely Shree Nav Shanti Secondary School Birendra Bazar and Shree Super Sense Secondary School Dharapani. The students of grade X of these two schools were taken as the sample of the study. Among the students of these two

schools the students of grade X of NSSS were selected randomly by tossing a coin as experimental group whereas that of SSSS as control group.

Variables of the Study

Variable is a measurable characteristic that varies. They are things that a researcher measures, controls or manipulates in the research. According to Kerlinger "A variable is a property that takes on different values." The variables in this study were categorized as follows:

Independent Variables: Variables are the condition or characteristics that the experimenter manipulates, controls, or observes. The independent variables are the conditions or the characteristics that the experiment manipulates or control in his or her attempt as certain their relationship to observed phenomena. The independent variables of the study were the treatment and instruction through dynamic mathematic software geogebra.

Dependent Variables: The dependent variables are the condition or characteristics that appear, disappear or change as the experimenter introduces, removes, or changes independent variables (Best and Khan, 2006, p.169) .In this study, students' achievement test, class observation and student's perceptions were taken as dependent variables.

Stages of Experiment

This research had been completed in the following three stages:

Pre –experimental Stage: In this first stage, preparation of episodes teaching slides preparation of materials, validation of the prepared episodes by the help of the supervisor and subject experts. furthermore, the researcher had planning ,preparation, and piloting the achievement test for pre test ,administration of the pre test and analyzing the pre test result in this stage.

Experimental Stage: In this second stage, the researcher taught the students of Shree Nav Shanti Higher secondary school by using geogebra whereas, the students of Shree Super Sense Higher secondary school taught by the researcher by using traditional method,

Post –experimental Stage: In the final stage of the experiment, the posttest administrated in both groups .Likert's scale only administrated to the experimental group then obtained results analyzed and interpreted.

Threats to Validity of Experimental Research

There are basically two types of threats to validity in experimental research which explained as follows

Internal Validity in Experimental Research

Internal validity is the extent that an experiment shows a cause-effect relationship between the independent and dependent variables (grant math and Polson, 2003). Many factors exist that effect the internal validity of a study, care was given to eliminate as many of these factors as possible. Subject characteristics, morality, history, instrumentation testing and implementation were possible threats to internal validity in the present study. In this part, ways of controlling these threats were explained.

Subject Characteristics: First of all, subject characteristics are one of the possible threats to internal validity in the present study. The characteristics of subject which might affect the internal validity were student's age and their socioeconomic statuses. Student who participate in the present study were the same grade level, so their ages were close to each other. So these characteristics did not influence the result accidentally.

Experimental Mortality: Experimental mortality means the loss of subjects during the period of experimentation. But, hereon participation of the experimental and the control group lost during the experiment. There were same number of respondent in the pre test and post test on both groups.

Statistical Regression: An effect that is a result of a tendency for subjects selected on the basis of expertise score to regress towards the mean on subsequent task is called statistical regression (Best and Khan, 2009). In this study the naturally intact groups were taken as experimental and control groups. Both the groups were of mixed ability.

History: Events outside of the study/experiment or between repeated measures of the dependent variable may affect participants' responses to experimental procedures. Often, these are large scale events (natural disaster, political change, etc.) that affect participant's attitudes and behaviors such that it becomes impossible to determine any change on the dependent measures is due to the independent variables

Selection Bias: Selection bias which is likely to affect the internal validity results when results the researcher makes a comparison between the non equivalent experiment and control group. It is another treat to the experiment. But in this study, the equivalency of two groups at the beginning of the study was censured by the analysis of protest results.

External Validity in Experimental Research

External validity is the extent to which the variable relationship can be generalized to other treatment variables, other measurement variable and other populations (Best and Khan, 2009, p.171). The possible factor that affects the external validity and their controls are discussed as below:

Interaction Effect of Testing: The use of pre-test at the beginning of study may sensitize individuals by making them more aware of concealed purpose of researcher and may serve as a stimulus to change. The study was doing short period of time as well as the researcher made question structure of pre-test and post test differ.

Artificial Situation of the Experiment: The researcher tries his/her best to control all extraneous variables so that they may not produce any experimental change. As a consequence of this effort, the experimental situation becomes more artificial and less resembles the life situation regarding which generalizations are to be made. But to control such problem the groups were formed in the naturally assembled class.

Interaction of Selection and Treatment: Sample used in the most classroom experiment is usually composed of intact groups, not of randomly selected individuals. They are based on accepted invitation to participates, some schools accepts agree to participate others disagree. One cannot assure that samples taken for cooperating schools representative of the target population, which included schools that would not cooperate (Best and Khan,2009). In this study, researcher selected himself taught both class experimental group and the control groups were taken as equivalent group to the experimental group.

Data Collection Tools

Achievement Test: The pre- test used to determine the achievement level of the students in both groups. This test consists of subjective questions to be solved without using geogebra that had answered by both groups experimental and control groups. Post-test contained subjective questions that have a slightly different with the questions of the pre- test, but the questions are the same in structure. Post- tests used

to measure the student's achievement after using geobebra. These tests involved both the control group and the experimental group (See Appendices-A and B).

Table2: levels, types, number and marks of subjective and objective questions

Level of questions to be asked	Types of questions to be asked	Total questions to be asked	Number of questions to be answered and marks allocated
Knowledge and Understanding	Multiple choice items	10 questions	10x1 marks
Skills	Short answer questions	5 questions	10x2 marks
Problem Solving	Long answer questions	5 questions	20x5 marks
Total		20 questions	40 marks

Students Perceptions: This perceptions scale contained ten items using a Likert's scale of '1-Strongly Disagree, 2-Disagree, 3-Undecided, 4-Agree and 5-Strongly Agree'. This scale contained the statements which reflected the student's perceptions towards the use of geogebra (See Appendix-G).

Class Observation Note

During the experimental phase the researcher coded the students' regularity in class room, participation, performance, interaction and interest on subject matter which reflect the effectiveness of geogebra in teaching mathematics (See the Appendix-H)

Reliability and Validity of Research Tools

The researcher constructed an achievement test items consisting of objective and subjective type questions related to the selected topics. The content validity of test items established and approved by my supervisor, the mathematic experts as well as

school mathematics teachers. For the reliability of test items, difficulty level of test items found by the pilot study which carried out with 15 students enrolled in grade X of Shree B.S. Niketan Secondary School Birendra Bazar, Dhanusha. Before administrating the test items the researcher instructed the students about the way of responding the test items.

A pilot study conducted to assess the reliability of instruments. The pilot study was carried on 15 students of grade X of Shree B.S.Niketan Secondary School. Each student's first and second responses were matched for scale items to see whether rating is same of five points Likert's scale. Every item was evaluated on its merit type. This perception scale contained ten items using a Likert's method. The validity of student's perception scale was determined by the curriculum, text book, previous test items and the expert judgment.

Data Collection Procedures

The procedure of data collection describes how to relevant data and information is gathered. This study mainly was based on the quantitative data obtained from achievement test. At first, the researcher visited Shree Nav Shanti Higher Secondary School, Birendra Bazaar and Shree Super Sense Higher Secondary School Dharapani. Then the researcher took consent with Principals and subject teachers to undertake the desired activity. Experimental group was taught by using geogebra and control group was taught without using geogebra for two weeks. Among them, researcher taught experimental group and another group is as usual. The duration of each period was 45 minutes. At the end of teaching session, item test administrated to both the groups with the help of same test items. And student's perception scale administrated to the experimental group only.

Data Analysis Procedures

Result and discussion are considered as the blueprint of any research work. 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). The data analysis for this research had done by quantitatively as well as qualitatively with the help of both descriptive and inferential statistics. Thus achievement test scores analyzed using inferential statistics. Specifically, the t-test has executed for hypothesis testing. The t-test has used to test for statistical significance difference between the control and experimental groups at the beginning of the study and at the end. This was done primarily by comparing the mean score of the test score of both the groups. Descriptive statistics also used to analyze the data from the perception scale towards Liker's scale to find out student's perceptions towards using geogebra in teaching mathematics of experimental group only.

Item Analysis of the Test

It is a process which examines student's responses to individual test items in order to assess the quality of the items as whole. Item analysis is the process of collecting; summarizing and using information from student's responses to assess the quality of the items. Difficulty index and discrimination index are two parameters which help to evaluate the standard of the test items. The researcher conducted the tests among 20/20 students of two selected schools**.** Out of 20 students, 27% of students taken as the upper and 27% of the students has taken as lower. The criteria for the acceptance or the rejection of the items were given in the appendix-E.

Ethical Considerations

Ethics is an essential element in any kind of research. It played a vital role in conducting shaping the framework of the study. By taking into consideration the

ethical codes and conduct. It guided the researcher to orient the work towards high level of ethical ideas. Ethical issues are inextricably interwoven in much of the qualitative or interpretative research(Cohen,Monion and Morrison, 2007).Any researcher needs to anticipate the ethical issues during their research work. In addition to conceptualizing the writing process of a proposal (Hesse-Bieber and leavey, 2006 cited in Cohen, Monion and Morrison 2007). On the issue of ethical Madden says, “Ethical issues are important not only in the field but also after their departure or till the end of their research”. So it is an ongoing association with particular group. The study would be carried out with informed consent from the participants. However, no written consent will be obtained from them and many of the participants are concerned about the implied commitment resulting from signing form. However, before participating interview the objectives and the study procedure verbally explained to each interviewee individually. Only those consents agreeing to participate in the study interviewed. Similarly, participant’s right to withdraw from the study at the time of interview or afterwards would be accepted and privacy of the respondents would be maintained. The participants can withdraw from the study at any time during or after without any consequences. The researcher has to ensure that this research project would be more a fruitful document for people like research participants, teachers, students and the educators.

Chapter IV

Analysis and Interpretation of Data

The data of the study were collected from grade X students on the basis of achievement test. The collected data were tabulated and analyzed for the study of attainment of the objectives and verification of the research hypothesis. This chapter deals with the statistical analysis and interpretation of the data on the basis of achievement test. These data were tabulated and analyzed using mean, standard deviation and two tailed t-test at 0.05, level of significance. The collected data were analyzed and interpreted and interpreted under the following sub headings:

- Analysis of Pre test Scores
- Analysis of Post test Scores
- Analysis of Pre test and Post test Scores
- Analysis of the Student's Perceptions towards Geogebra
- Analysis of Class Observation Note

Analysis of Pre-test Scores

The computation of mean, standard deviation and calculated t-value of the experimental and control groups on pretest score given by the following table:

Table 3: Scores of Groups on Pre-test

Groups	N	Mean	S.D.	∝	Calculated t-value	Tabulated t value	Decision
Control	20	18.05	3.44	0.05	-1.64	1.96	Null hypothesis is accepted
Experimental	20	22.7	4.91				

The above table 3 shows that the mean and SD of control group were 18.05and 3.44 respectively whereas the mean and SD of experimental group were 22.7 and 4.91 respectively on pretest. Since, the calculated t-value i.e. -1.64 was less than the tabulated t-value i.e. 1.96 at 0.05 level of significance. Thus, null hypothesis was accepted. Therefore, there was no significance difference between the students achievement score taught by Geogebra over the traditional methods on pretest.

Analysis of Post-test Scores

Table 4:

Scores of Groups on Post-test

Groups	N	Mean	S.D.	Calculated t value	Tabulated t value	Decision
Control	20	18.15	3.26	2.36	1.96	Null Hypothesis was rejected
Experimental	20	22.65	3.80			

Since the above table shows that the mean and standard deviation of control group were 18.15 and 3.26 respectively whereas the mean and standard deviation of experimental group were 22.65 and 3.80 respectively. The calculated t –value i.e. 2.36 which was more than the tabulated value of t-test i.e. 1.96 at 0.05, level of significance. So, H_1 was accepted. Hence, there was statically differences between the student's achievement score of taught by GeoGebra that of control group i.e. students achievement score of experimental group is higher than the achievement score of control group on post-test.

Comparative Analysis of the Pre-test Scores

The mean score of the pre-test of control group was 18.05 and experimental group was 22.7 whereas, the mean score of the post test of control and experimental

groups were 18.15 and 22.65 respectively. Thus, total mean score on pre-test and post test were 20.37 and 20.4 respectively. Hence, the mean score of the post test was greater than the pre test. Thus, Geogbra is effective tool in teaching and learning mathematics over the tradition methods.

Comparative Analysis of the Pre-test and Post-test Scores

The mean score of the pre-test of control group and experimental group were 18.05 and 22.7 respectively, whereas the mean score of the post test of control and experimental group were 18.15 and 22.65 respectively. Thus, total average of the pre-test and post test of the groups were 20.37 and 20.4 respectively. Hence, the mean score on post test was greater than the pre test. Thus, use of geogebra is more effective than the traditional method.

Analysis of Student's Perceptions towards GeoGebra

The perception of the students was analysed with a set of questionnaire based on the five point Likert's scale with the help of the following statements over all the students of experimental group.

Table 5: Student's Perception

S.N.	Statements	SD	D	UD	A	SA	Mean	SD
		1	2	3	4	5		
1.	It is important that I use geogbra in my learning.	0	0	0	6	14	4.7	0.47
		-	-	-	30%	70%		
2.	Geogebra helps to learn mathematical concepts.	0	1	1	10	8	4.25	0.78
		-	5%	5%	50%	40%		
3.	I feel confident when the activities do by using geogebra.	0	2	3	5	10	4.15	1.03
		-	10%	15%	25%	50%		

4.	When I use geogebra at they make learning more interesting.	0	0	4	9	7	4.15	0.74
		-	-	20%	45%	35%		
5.	I am happy if the teacher uses the geogebgain teaching mathematics.	0	0	2	12	6	4.2	0.61
		-	-	10%	60%	30%		
6.	I learn a lot about Mathematics when using geogebra.	0	1	3	11	5	3.95	0.79
		-	5%	15%	55%	25%		
7.	I can think creatively and critically when using geogebra.	0	1	2	10	7	4.15	0.81
		-	5%	10%	50%	30%		
8.	Geogebra helps increase achievements in mathematics.	0	1	2	9	8	4.2	0.83
		-	5%	10%	45%	40%		
9.	I am excited when asked to explore the geogebra.	0	1	3	10	6	4.05	0.82
		-	5%	15%	50%	30%		
10.	I think geogebra is an essential component for learning mathematics.	0	0	3	9	8	4.25	0.71
		-	-	15%	45%	40%		

The above table 5 shows that the mean and standard deviation of the statement ' It is an important that I use geogebra in my learning' are 4.7 and 0.47 respectively and about 30 % of the students agreed with the statement and 70% of the students strongly agreed with the statement. It shows that students are in favour of the statement ' It is an important that I use geogebra in my learning'.

The mean score and S.D of the statement ‘Geogebra helps to learn mathematical concepts’ are 4.25 and 0.78 respectively about 5 % of the students disagreed with the statement and 5% of the students undecided with the statement, 50% of the students agree and about 40% of the students have shown their strongly agreed views. It is shows that students are in favour of the statement ‘Geogebra helps to learn mathematical concepts’.

The mean score and SD of the statement ‘ I feel confident when the activities do by using geogebra’ is 4.15 and 1.03 respectively and about 10% of the students disagreed with the statement ,15% of the students undecided with the statement, 25% of the students agreed and 50% of the students have shown their SD views.

The mean score and SD of the statement ‘ When I use ICT tools at they make learning more interesting’ are 4.4.15 and 0.74 respectively and about 20% of the students undecided , 45% of the students agreed with the statement and about 35%% of the students have shown their SA views. It shows that students are highly positive attitude with the statement ‘ when I use geogebra at they make learning more interesting’.

The mean score and SD of the statement ‘ I am happy if the teacher uses the geogebra in teaching mathematics’ are 4.2 and 0.61 respectively and about 60% of the students agreed with the statement ,30% of the students strongly agreed with the statement, and about 10% of the students have shown their undecided views. It shows that students are favour with the statement ‘ I am happy if the teacher uses the geogebra in teaching mathematics’.

The mean score and SD of the statement ‘ I learn a lot about Mathematics when using geogebra’ are 3.95 and 0.79 respectively and about 5% of the students disagreed with the statement , 15% of the students undecided with the statement,55%

of the students agreed and about 25% of the students have shown their SA views. It shows that students are favour with the statement ' I learnt a lot about Mathematics when using geogebra'.

The mean score and SD of the statement ' I can think creatively and critically when using geogebra' are 4.15 and 0.81 respectively and about 5% of the students disagreed with the statement ,10% of the students undecided with the statement, 50% of the students agreed and about 30% of the students have shown their SA views. It shows that the majority of the sample students were favour with the statement ' I can think creatively and critically when using geogebra'.

The mean score and SD of the statement 'geogebra helps to increase my achievements in mathematics' are 4.2 and 0.83 respectively and about 45% of the students agreed with the statement , 40% of the students strongly agreed ,5% of the students disagreed with the statement, about 10% of the students have shown their undecided views. It shows that students are highly positive favour with the statement 'geogebra helps to increase my achievements in mathematics'.

The mean score and SD of the statement ' I am excited when asked to explore the geogebra' are 4.2 and 0.82 respectively and about 50% of the students agreed with the statement, 5% of the students disagreed with the statement, and about 15% of the students have shown their undecided views. It shows that students are favour with the statement ' I am excited when asked to explore the geogebra'.

Finally, the mean and SD of the statement 'I think that geogebra is an essential for learning mathematics' are 4.25 and 0.71 respectively and about 15% of the students undecided with the statement, 45% of the students agreed and 40% of the students strongly agreed with the statement which shows that the students have positive perception towards using geogebra in teaching learning mathematics.

Analysis of Class Observation Note

The researcher developed a class observation for to measure the participation, interest, performance and attendance of the students of the both groups. The percentage of the students was calculated in the duration of teaching.

Table 6: Result of Class Observation Note

		Groups	
		Experimental	Control
Participation and Interest (%)	Active	82.5	62.03
	Moderate	12	6
	Passive	5.2	17.02
Performance on Subject matters (%)	CW	90	76
	HW	90	70
Attendance (%)		100	98

From the above table it shows that the students are more active in their classroom in the experimental group. They had also done their home works and class works regularly. In the experimental group, 82.5 % of the students were actively participated whereas only 63.0 3 % of the students were actively participated in control group in the class .Moreover, the use of geogebra seems to be more effective than the use of tradition method in teaching mathematics.

Chapter V

Conclusions and Implications

After analyzing and interpreting the data, the researcher interpreted the summary, findings and recommendations for the further study.

Summary of the Study

The purpose of this chapter is to present precisely the result of the study. The research was held in the title of "Effectiveness of Geogebra in Teaching Mathematics". The geogebra had been used to conduct the mathematics lessons of secondary levels in comparison to the lesson conducting in traditional method.

The conclusions of the research had been drawn from the test items provided to the students and score obtained by the students. The pre-test and post-test experimental design used to get the significance of the use of geogebra. The pre-test and post-test of control group were compared to the pre-test and post-test of experimental group in which the treatment group had done better in the case of learning mathematics with the use of geogebra.

In the study the students of secondary level were taken as the population and the students of grade X were taken as the sampling. The 20 students of class X had been selected and the students divided into two groups. Among them 20were selected as control group and 20 of them were selected as the experimental group in which the group of experimental was taught the mathematics through the use of geogebra. In order to get the effectiveness of the geogebra, Control group was taught by traditional methods.

After teaching two weeks by using geogebra, researcher collected data from mathematics achievement test and mathematics student's perception from the

experimental group whereas control group was taught by as usual conventional methods or tradition methods.

Two hypotheses were generated for this study as indicated in chapter one. The result of pre-test subjected to t-test to determine the initial mathematical background of the students. The result of t-test as displayed table 4 showed that there was no statistically significant difference between the mean scores of the two groups, the second hypothesis, as displayed in table 5, was rejected at 0.05, level of significance by using t-test statistics. By implications, students taught with geogebraperformed better in the post-test than pre-test student achievement test in mathematics.

In this study, the teaching and learning of mathematics using geogebra has been effective. This was shown through the improved scored of the students in the experimental group. The result highlighted that students in the experimental group performed better using geogebra than the control group that using the traditional learning methods. In addition, students in the experimental group better in the post-test compared to the control group. The student's perception was identified through a Likert's scale consisted of ten items. This scale was distributed to the experimental group only to know their perception based on their experiences using the geogebra.

Findings of the Study

From the existing statistical analysis of the collected data and interpretation were found the following results as the major of the study.

- Analysis of average mean scores and percentage of the scores obtained by the students of the experimental group and the control group in pre-test showed that two groups were equivalent or homogenous before the treatment.

- Analysis of the pre-test mean scores between total experimental and total control group showed that there was no statistically significant difference in mathematics achievements between these two groups .It means the understanding level of two groups were equivalent or homogenous before the treatment.
- Analysis of the average mean scores and percentage of the scores in post-test obtained by the students taught with geogebra tool and taught with traditional method in teaching mathematics helped the students to learn better. From the analysis it was also found that the teaching with use of geogebra helps the students to learn better than the teaching without geogebra.
- Analysis of Post-test mean scores between the experimental and control group students showed that there was statistically significant difference in mathematics achievement between these two groups. The experimental group students taught by using geogebra performed better than the control group students taught without geogebra.
- Comparison between pre-test and post-test mean score of total experimental group students, which was taught with using geogebra tool showed that post-test achievement was significantly better than that of pre-test.
- The student's perception on learning process of mathematics was highly positive in using geogebra than use of traditional methods.

Conclusions

There was no significant difference between experimental group and control group students in pre-test results. Thus, the performance of both groups in

mathematics was same before the treatment. There was significant difference in post-test mean scores of student in mathematics taught with using geogebra and traditional method. The mean achievement of students taught by using geogebra was significantly better than the students taught by traditional methods. Thus, the study revealed that the use of geogebra in teaching and learning mathematics is more effective at secondary level. From this study it was concluded that the use of geogebra helps the students to understand mathematics in better way and consequently students performed better in achievement over conventional methods.

Implications of the Study

Based on results and discussions of the present study several implications of geogebra assisted instruction refers to the education who wish to implement geogebra tool assisted instruction at kindergarten to university level and to the researchers for future investigation on this topic were presented by the following sections:

Policy Level:

Ministry of education and NCED should encourage the teachers through trainings to improve the existing traditional methods by use of ICTs. For these NCED and MOE should organize the various training programs, workshops, conferences etc. Therefore, it is important that policy as well as school directors invest both resources and time in the training of teachers. The results of this study also suggest that policy makers can more actively encourage the use of ICTs assisted instruction with poor learning outcomes. Thus, this research work also shows that adaptive GUI-tools might be efficient tools to increase learning outcomes.

Practice Level:

Traditional teaching in Nepal is based on the teaching and learning model of transmission of knowledge and skills through a drill and practice method. The teacher explains the theories, some examples and the students have to make exercises to practice a bit more. In other words, teaching and learning is content-driven and teacher-cantered. In my experiment, I designed lessons on mathematics that was not focusing on pouring the knowledge and skills into the student's heads. On the contrary, I focused more on the process of learning of the students and gave students an important role in their own learning, i.e. I had the goal to actively engage them in learning activities. I gave students sample opportunities to link theory with practical experiences. I took their findings into account and I let them discuss with peers and with the entire classroom. Under my supervision the students were more or less building up by themselves a network of knowledge and skills about the subjects of mathematics. Thus, mathematics teacher should be encouraged to use and adopt the ICTtogether with teaching methods. The mathematics teacher should be encouraged to emphasize the group discussions and students centered methods instead of regular lecture method by using geogera.

Further Level:

This study has focused on only improvement of student's achievement and positive perceptions toward use of geogebra on mathematics lessons based on quasi-experimental design with small sample size. Other researchers may carry out a study with in large sample in order to increase effectiveness of geogebra in mathematics lessons. Based on the research, the research had made following implications for the further study.

- It is recommended that further study may be carried out in order to identify the articulation of mathematics curriculum in terms of the flow of ICTs in schools and effectiveness of policy provisions of integrating ICT into school mathematics teaching of Government of Nepal.
- It is recommended that further research may be conducted to explore effectiveness of ongoing of ICT based instruction in other mathematics lesson.
- Effective training model of ICTs usage in teaching and learning.
- This type of study should also be conducted at all levels of schools and in other subjects as well.
- Ministry of Education and Centre for Education and Human Resource should play the facilitating role and provide experts and organize many training programs for the teacher to increase the efficiency of them.
- It is recommended to conduct further study on the use of geogebra in collaborative learning in mathematics.

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APPENDICES

Appendix -A

Pre-test Questions

Student's Code number: …… **Time: 30 Minutes**

Subject: Opt. Mathematics **Full Marks: 40**

Group: Experimental / control **Pass Marks: 20**

School's name: …….

Attempt <u>All</u> the questions.

'<u>Group</u>- A'

1. If A= $\begin{bmatrix}1 & 2\\ 2 & 1\end{bmatrix}$, then the adjoint matrix of A is:

a)$\begin{bmatrix}1 & -2\\ -2 & 1\end{bmatrix}$ b)$\begin{bmatrix}2 & 1\\ 2 & 1\end{bmatrix}$ c)$\begin{bmatrix}1 & -2\\ -1 & -1\end{bmatrix}$ d)) $\begin{bmatrix}-1 & 2\\ 2 & -1\end{bmatrix}$

2. If the matrix A is order of 2x3 and B is order 3x2 then

a)2x3 b)3x2 c)3x3 d)2x2

3. A matrix having the same number of rows and columns is called... matrix.

a)scalar b) diagonal c)square d)rectangular

4. The matrix A =$\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$is a

a)unit matrix b)null matrix c)rectangular matrix d)equal matrix

5. What is the transpose of the matrix A =$\begin{bmatrix}1 & 4\\ 8 & 7\end{bmatrix}$

a) $\begin{bmatrix}1 & 4\\ 8 & 7\end{bmatrix}$ b) $\begin{bmatrix}1 & 8\\ 4 & 7\end{bmatrix}$ c)$\begin{bmatrix}8 & 1\\ 7 & 4\end{bmatrix}$ d)$\begin{bmatrix}8 & 1\\ 8 & 7\end{bmatrix}$

6. The determinant of the matrix A =$\begin{bmatrix}2 & -1\\ 1 & -2\end{bmatrix}$is

a) -3 b)3 c)0 d) 2

7. A square matrix A is said to be a singular if determinant of A is equal to

a) 0 b) 1 c) -1 d) non zero

8. If $\begin{pmatrix} -1 & 0 \\ 0 & -2 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix}=\begin{pmatrix} -2 \\ 4 \end{pmatrix}$ then the value of x and y:

a)-2 and -2 b)2 and -2 c)-2 and 2 d)2 and 2

9. Solve the following system of linear equations by matrix method:

3x+7y=5 and x-2y= -7

a)x= 3,y=2 b)x=-3 ,y=2 c)x=2 ,y=3 d) x= -3 , y = -2

10.Let A =(-3) be a matrix then the det. of A =

a)3 b) -3 c) 0 d) doesn't exist

'Group –B'

11. Construct a 2x2 matrix whose elements a are given by a=2i –j

12. If A=$\begin{pmatrix} 2 & 0 \\ -3 & 1 \end{pmatrix}$ and B=$\begin{pmatrix} 0 & 1 \\ -2 & 3 \end{pmatrix}$, find 2A-3B

13. Define scalar matrix with an example.

14. Find AB if A=$\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$ and B=$\begin{bmatrix} 3 & 2 \\ 6 & 4 \end{bmatrix}$.

15. For what value of k the matrix A=$\begin{pmatrix} 2 & k \\ 3 & 5 \end{pmatrix}$ has no inverse?

'Group –C'

16. Solve by matrix method

5x-3y+2=0

4x+2y-5=0

17. If A= $\begin{bmatrix} 3 & 1 \\ -1 & 2 \end{bmatrix}$, find the value of A-5A +7I, where I is the unit matrix of order 2.

18. If A= $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$ and B = $\begin{pmatrix} 1 & 0 \\ 0 & 4 \end{pmatrix}$, show that AB= BA.

19. Define a matrix with examples .Also, state the different types of matrix.

20. Solve the equation $\begin{bmatrix} 2 & 1 \\ 5 & 0 \end{bmatrix}$-3x =$\begin{bmatrix} -7 & 4 \\ 2 & 6 \end{bmatrix}$

Best of Luck

Appendix–B

Post-test Questions

Student's Code number: …… **Time: 30 Minutes**

Subject: Opt. Mathematics **Full Marks: 40**

Group: Experimental/control **Pass Marks: 20**

School's Name: …….
Attempt <u>all</u> the questions.

<u>'Group- A'</u>

1. If A = $\begin{bmatrix}1 & 2\\ 2 & 1\end{bmatrix}$ then the adjoint matrix of A is:

a)$\begin{bmatrix}1 & -2\\ -2 & 1\end{bmatrix}$ b)$\begin{bmatrix}2 & 1\\ 2 & 1\end{bmatrix}$ c)$\begin{bmatrix}1 & -2\\ -1 & -1\end{bmatrix}$ d)) $\begin{bmatrix}-1 & 2\\ 2 & -1\end{bmatrix}$

2. If the matrix A is order of 2x3 and B is order 3x2 then

a)2x3 b)3x2 c)3x3 d)2x2

3. A matrix in which the number of rows is not equal to the number of columns is called... matrix.

a)scalar b) diagonal c)square d)rectangular

4. The matrix A =$\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$is a

a)unit matrix b)null matrix c)rectangular matrix d)equal matrix

5. What is the transpose of the matrix A =$\begin{bmatrix}-1 & 2\\ 3 & -4\end{bmatrix}$

a) $\begin{bmatrix}-1 & 3\\ 2 & -4\end{bmatrix}$ b) $\begin{bmatrix}3 & -4\\ -1 & 2\end{bmatrix}$ c)$\begin{bmatrix}2 & -2\\ -4 & 3\end{bmatrix}$ d)$\begin{bmatrix}-1 & 2\\ 3 & -4\end{bmatrix}$

6. The determinant of the matrix A =$\begin{bmatrix}2 & -1\\ 1 & -2\end{bmatrix}$is

a) -3 b)3 c)0 d) 2

7. A square matrix A is said to be anon singular if determinant of A is equal to

a) 0 b) 1 c) -1 d) 2

8. If$\begin{pmatrix}-1 & 0\\ 0 & -2\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}-2\\ 4\end{pmatrix}$ then the value of x and y:

a)-2 and -2 b)2 and -2 c)-2 and 2 d)2 and 2

9. Solve the following system of linear equations by matrix method:

x-2y=1 and 2x-y= 5

a)x= -3,y=2 b)x= 3 ,y = 1 c)x=1,y=3 d) x= -3 , y = -1

10. Let A =$\begin{bmatrix}1 & 0\\0 & 1\end{bmatrix}$ be a matrix then the det. of A =

a)3 b) -1 c) 0 d) 1

‘Group –B’

11. Construct a 2x3 matrix whose elements a are given by a_{ij}=3i –2j

12. If A=$\begin{pmatrix}2 & 0\\-3 & 1\end{pmatrix}$ and B=$\begin{pmatrix}0 & 1\\-2 & 3\end{pmatrix}$, find 2A+3B

13. Define a matrix with an example.

14. Find BA if A=$\begin{bmatrix}1 & 3\\2 & 4\end{bmatrix}$ and B=$\begin{bmatrix}3 & 2\\6 & 4\end{bmatrix}$.

15. For what value of k the matrix A=$\begin{pmatrix}2 & k\\3 & 5\end{pmatrix}$ has no inverse?

‘Group –C’

16. Solve by matrix method

3x-3y-11=0

9x-2y-5=0

17. If A= $\begin{bmatrix}3 & -1\\-1 & 2\end{bmatrix}$, show that A-5A +7I=0, where I is the unit matrix of order 2.

18. If A= $\begin{pmatrix}2 & 4\\1 & 3\end{pmatrix}$ and B = $\begin{pmatrix}-1 & 5\\3 & -2\end{pmatrix}$, show that AB≠BA.

19. Define the following matrices with a suitable:

a)Diagonal matrix b)Row matrix c) Column matrix d)Equal matrix.

20. Solve the equation $\begin{bmatrix}2 & 1\\5 & 0\end{bmatrix}$ -3$\begin{bmatrix}a & b\\c & d\end{bmatrix}$ =$\begin{bmatrix}-7 & 4\\2 & 6\end{bmatrix}$.

Best of Luck

Appendix – C

Pre-test Scores

S.N.	Score of Control Group	Score of Experimental Group
1	24	26
2	23	25
3	22	25
4	16	21
5	16	20
6	14	17
7	13	15
8	15	18
9	16	19
10	18	21
11	19	22
12	19	21
13	17	18
14	13	18
15	19	23
16	24	35
17	16	28
18	16	29
19	20	27
20	21	26

Appendix- D

Post-test Scores

S.N.	Score of Control Group	Score of Experimental Group
1	25	27
2	23	27
3	21	25
4	17	19
5	17	21
6	18	20
7	19	23
8	19	24
9	20	22
10	21	22
11	20	23
12	16	24
13	15	19
14	14	18
15	13	16
16	19	25
17	17	24
18	15	20
19	13	21
20	21	33

Appendix-E

Items Analysis of the Test

No. of Questions	No. of Students														
	Upper 27%						Lower 27%					Total	P %	D.	Remarks
	1	2	3	4	5	6	16	17	18	19	20				
1	0	0	0	1	0	0	1	0	0	0	1	5	25	0.14	Rejected
2	1	1	1	1	1	1	1	0	1	0	1	14	70	0.33	Accepted
3	1	1	0	1	1	1	0	1	1	0	0	13	65	0.42	Accepted
4	1	1	1	1	1	0	0	1	0	1	1	13	65	0.42	Accepted
5	1	1	0	1	1	1	1	0	1	0	1	15	75	0.42	Accepted
6	1	1	1	1	1	1	0	0	1	0	0	12	60	0.33	Accepted
7	1	1	1	1	1	1	0	0	0	1	0	12	60	0.71	Accepted
8	1	1	0	1	1	1	1	1	1	0	0	14	70	0.42	Accepted
9	1	1	1	1	1	1	0	1	0	0	1	14	70	0.57	Accepted
10	1	1	1	0	1	1	0	0	0	1	1	12	60	0.57	Accepted
11	1	1	1	1	1	1	0	1	1	0	0	13	65	0.71	Accepted
12	1	1	1	0	1	1	1	0	0	0	1	14	70	0.42	Accepted
13	1	1	1	1	1	1	0	1	0	1	0	13	65	0.71	Accepted
14	1	1	1	0	1	1	1	0	1	0	0	11	55	0.57	Accepted
15	1	1	1	1	0	1	0	1	0	0	0	13	65	0.57	Accepted
16	1	1	1	1	1	1	1	0	1	1	1	14	70	0.77	Accepted
17	1	1	1	1	0	1	0	0	0	1	0	11	55	0.77	Accepted
18	1	1	1	1	1	1	1	1	0	0	0	12	60	0.57	Accepted
19	1	1	1	1	0	1	1	0	1	0	0	14	70	0.57	Accepted
20	1	1	1	1	1	0	0	0	0	1	1	12	60	0.42	Accepted
Even Sum	10	10	9	7	10	8	6	4	5	4	6				
Odd Sum	9	9	7	10	6	9	3	4	4	3	3				
Total	19	19	16	17	16	17	9	8	9	7	9				

Appendix-F

Split Half Reliability of the Test

S.N	Score of odd items(X)	Score of even items(Y)	X^2	Y^2	XY
1	**9**	**10**	81	**100**	90
2	**9**	**10**	81	**100**	**90**
3	**7**	**9**	49	**81**	**63**
4	**10**	**7**	100	**49**	**70**
5	**6**	**10**	36	**100**	**60**
6	**9**	**8**	81	**64**	**72**
7	**8**	**4**	64	**16**	**36**
8	**9**	**6**	81	**36**	**54**
9	**8**	**4**	64	**16**	**32**
10	**9**	**5**	81	**25**	**45**
11	**7**	**4**	49	**16**	**28**
12	**9**	**6**	81	**36**	**54**
N=12	**$\sum X$=100**	**$\sum Y$=83**	**$\sum X^2$=848**	**$\sum Y^2$=639**	**$\sum$XY=694**

Correlation Coefficient (r_{xy}) = $\frac{N\sum XY-\sum X\sum Y}{\sqrt{N\sum X^2-(\sum X)^2}\ \sqrt{N\sum Y^2-(\sum Y)^2}}$ **=0.0374**

Also, Reliability Coefficient (r) = $\frac{2r_{XY}}{1+r_{XY}}$ **=0.072**

Appendix-G

Student's Perceptions towards Geogebra

Dear students,

Read the each items carefully and tick (✓) which you feel the best option.

Where, SD=Strongly Disagree, D= Disagree, UD= Undecided, A= Agree and SA=Strongly Agree

S.N.	Statements	SD	D	UD	A	SA
1	It is an important that I use geogbra in my learning.					
2	Geogebra helps to learn mathematical concepts.					
3	I feel confident when the activities do by using geogebra.					
4	When I use geogebra it makes learning more interesting.					
5	I am happy if the teacher uses the geogebgain teaching mathematics.					
6	I learn a lot about Mathematics when usinggeogebra.					
7	I can think creatively and critically when using geogebra.					
8	Geogebrahelps to increase my achievement in mathematics.					
9	I am excited when asked to explore the geogebra.					
10	I think geogebra is an essential component for learning mathematics.					

Appendix: H

Class Observation Form

R. N.	Name of students	Participation and Interest			Performance on Subject matter		Attendance
		Active	Moderate	Passive	CW	HW	
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Appendix-I

Statistical Formulas

1. Mean $(\overline{X})$ = $\frac{\sum X}{N}$

2. Level of Difficult (P) =$\frac{R}{T}$ X100

Where,

R= No. of students getting correct answer

T= No. of students of appeared in the test items

3. Discrimination index level (D) = $\frac{U_R - L_R}{T}$

Where,

U_R= Right angel by upper 27%

L_R = Right answer by lower 27%

N= Total no of students included in item analysis upper and lower group

4. t- Value $= \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{N_1 {\sigma_1}^2 + N_2 {\sigma_2}^2}{N_1 + N_2 - 2}\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$

Where,

$\overline{X_1}$ =Mean of first sample

$\overline{X_2}$= Mean of second sample

N_1= No. of students in first sample

N_2= Number of student in second sample

σ_1^2= Variance of first sample

σ_2^2= Variance of second sample

5. S.D. =$\sqrt{\frac{\sum(x-\bar{x})^2}{N}}$