

EFFECTIVENESS OF GEOGEBRA IN TEACHING MENSURATION

A

THESIS

BY

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Letter of Certificate

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Letter of Approval

This thesis entitled “**Effectiveness of Geogebra in Teaching Mensuration**” submitted by **Mr. Janak Raj Joshi** in partial fulfillment for requirement of Degree of Masters in Mathematics Education has been approved.

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Recommendation for Acceptation

This is to certify that Mr. Janak Raj Joshi, has completed his thesis entitled **“Effectiveness of Geogebra in Teaching Mensuration”** under my supervision during the period prescribed by the rules and regulation of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommended and forward his thesis to the Department of Mathematics Education to organize final viva-voce.

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Dedication

To my parents

Declaration

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

Date:

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Janak Raj Joshi

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Date:

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Janak Raj Joshi

Abstract

The topic of this study is “**Effectiveness of GeoGebra in teaching Mensuration**”. The purpose of this research was to find out the effect of use of Geogebra in teaching mensuration at grade X. In this study, pre- test post- test non-equivalent control group design of research was used which is one of the quasi-experimental research design. Social constructivism has been accepted as the theoretical foundation of this research. All the students of grade X of Kanchanpur district were taken purposively as population of study. This study was conducted on two groups of students: control group and experimental group. By random sampling method the students of Modern Montessori Bal Vidhyalaya, BDN- 02, Ultakham were selected for control group and Mahakali Modern Public School, BDN- 03, Bhansi for experimental group. A total of 52 students were participated in the study in which control and experimental group consists 23 and 29 students respectively. Control group was facilitated by traditional method of instruction but experimental group was treated by GeoGebra software up to three weeks.

Mathematics achievement test (MAT) and interview schedule were used to collect data. A pilot test was conducted in a group of students of Gyan Batika Secondary Boarding School, BNP- 06, Kanchanpur for reliability coefficient, difficulty level and discrimination index of items. To ensure the validity of items, tool was developed being based on specification grid of compulsory mathematics of grade X which was developed by CDC Nepal and with the help of supervisor. But for the reliability of items on interview schedule, students were asked the same questions repeatedly and for validation supervisor helped me.

A pre- test was conducted on both groups before teaching. After quantitative analysis of pre- test, I taught both the groups up to three weeks. Moreover, control

group was taught by traditional method of instruction while experimental group was facilitated by GeoGebra software being based on Social constructivist approach. After treatment a post- test was administered on the same both groups using the same set of items used in pre- test. After quantitative analysis of the result of post- test an interview schedule was used on a group of five students of experiment group to know their perception towards the use of GeoGebra in teaching mensuration. The collected data were analyzed by using descriptive statistics and inferential statistics both. Specially, t- test was used to test for the statistical significance difference between the control and experimental group using MS Excel 2013. The data obtained from interview schedule was analyzed by descriptive method.

The result of post- test showed that the average achievement of experimental group which was facilitated through GeoGebra software in constructive environment was better than that of control group which was taught by traditional method of instruction. Thus, analysis of this result indicated that GeoGebra was an effective software in teaching mensuration. Also the analysis of interview result indicated that most of the students gave the positive responses towards the use of GeoGebra software. Students of experimental group took the part in teaching learning activities actively. Also, they took GeoGebra as an essential software in learning other geometrical part of mathematics.

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Acronyms

BDN	=	Bheemdatt Nagarpalika
BNP	=	Bedkot Nagarpalika
CDC	=	Curriculum Development Center
CSA	=	Curved Surface Area
D	=	Dimension
ICT	=	Information and Communication Technology
MAT	=	Mathematics Achievement Test
MKO	=	More Knowledgeable Others
MMBV	=	Modern Montessori Bal Vidhyalay
MMPS	=	Modern Mahakali Public School
MS	=	Microsoft
N	=	Number of students
SD	=	Standard Deviation
TSA	=	Total Surface Area
ZPD	=	Zone of Proximal Development

Chapter I

INTRODUCTION

This research has focused on the effect of GeoGebra in teaching mensuration. This chapter includes background of the study, statement of the problem, objective of the study, hypothesis of the study, justification of the study, delimitation of the study and operational definition of the key terms.

Background of the Study

The history of mathematics tells us that mathematics was originated along with the human civilization. The term mathematics has been defined in various ways. Oxford Advanced Learner's Dictionary (2020, p.967) has defined mathematics as "Mathematics is the science of numbers and shapes where arithmetic, algebra, geometry and trigonometry are its branches". Similarly, according to the mathematics dictionary, "The logical study of shape, arrangement, quantity and many related concepts. Mathematics often is divided into three fields' algebra, analysis and geometry" (James & James, 1986, p.239). Also, according to the Prayogatmak Nepali Shabdakosh (2070 BS, p.337), "Mathematics is the science which study about number, quantity of number and place." These definitions covered the large area with branches of mathematics. Mathematics is defined by various mathematicians in various ways. According to Gauss, "Mathematics is the queen of science and the theory of number is the queen of mathematics." Similarly, Bacon defines mathematics as "Mathematics is the gateway and the key to all other sciences." We can add the definition of mathematics given by Hilbert also. He defined the term mathematics as "Mathematics is nothing more than a game played according to certain simple rules with meaningless marks on paper." Due to the own background of mathematicians

they had defined mathematics in their own way. But it can be concluded that mathematics is very important for human being.

Nowadays, mathematics is one of the most demanding subject due to its use in everywhere. Without mathematics one cannot live. Although some people say we do not need of mathematics but in every steps of human being it is important. It is regarded as the backbone of all sciences. Mathematics is taught every year from the beginning of elementary education through secondary education and in higher education. The developed countries has focused on the mathematical knowledge by which they are doing more effective work on science.

There are various branches of mathematics. Geometry is one of the main branch of mathematics. Mensuration is a part of geometry which deals with perimeter, area and volume of figure and solid objects. The concept related to mensuration like: length, shape, size, etc. is given from starting grades of school education. The concept related to this topic is used in every home and society knowingly or unknowingly by everyone.

Many researches shows that technology empowers students by giving them ownership of how they learn, making education relevant to their digital lives and preparing them for their future. With technology and access to resources beyond classroom walls, students are inspired to become problem-solvers, critical thinkers, collaborators, and creators. Where technology has been successfully integrated into classrooms, students develop a lifelong love of learning. Learning by doing with maker mindsets and environments can be very engaging when designed and integrated with the right technology.

People in the 21st century live in a technology and media-driven environment. The effective use of technology in education has changed the face of education and it has created more educational opportunities. The use of technology in education has removed educational boundaries, both students and teachers can collaborate in real time using advanced educational technologies (Ramey, 2013). The development of the technology made the human life easy and comfortable. Teaching learning activities are also affected by the development of modern technology.

To teach mathematics effectively, there are so many computer based software or ICT tools such as GeoGebra, Mathematica, Mat Lab etc. These software are very helpful for teachers as well as students to build the sense about the mathematical concept. GeoGebra is one of these software. This software was designed by Markus Hohenwater. It was originated in the master's thesis project at the University of Salzburg in 2002. It was designed to combine features of interactive geometry software and computer algebra system in a single, integrated and easy to use system for teaching and learning mathematics. Thus, GeoGebra is an open source dynamic mathematics software that incorporates geometry, algebra and calculus.

The existing school curriculum of Nepal has developed the concept of use of technology in education. Some teachers can deal with new technology but some of them do not have the skill to deal with new technology due to various problems. Also, our maximum schools are not so well equipped for effective use of technology. In the context of Nepal, the topic 'Mensuration' is introduced from basic level. The content is wide and deep in grade IX and X in compulsory mathematics curriculum of Nepal. Many students take mensuration as a difficult concept. When a teacher starts to teach this concept then students starts to rote the formulae. By rote learning students can solve the problems related with mensuration but they do not have the actual concept

about these problems. Here, the teaching materials, students centered teaching method etc. can play the vital role for effective teaching learning of mensuration concept. On this context, this study focused on the effectiveness of GeoGebra in teaching mensuration in grade X.

Statement of the Problem

In Nepal, mathematics is a compulsory subject from elementary level to secondary level. There is a paper of compulsory mathematics in SEE for 100 marks. Present curriculum of mathematics had included different topics in grade IX and X. Particularly, set, arithmetic, mensuration, algebra, geometry, trigonometry, statistics and probability are included in mathematics syllabus of grade X. 24 teaching hours were separated for mensuration topic and 16% weight covers in SEE examination.

Geometrical part is taken as a difficult concept in school level due to various causes. In my own experience also, it was difficult to develop the students understanding about the concept of mensuration. Maximum number of students just memorize the formulae and try to solve the problems. They unable to understand the figure or object in real sense. So, teaching and learning mensuration is one of the rigor & difficult task in our context for both teachers and students. The concept of mensuration deals with area, perimeter and volume. In this topic, visualization is very important for the students to solve problems. Visualization and exploration of mathematical objects and concept in multimedia environments can foster understanding in new ways (Voorst, 1999, as cited in Singh, 2019). But, our schools are unable for this due to various causes by which learners must rote the formulae to solve questions. The new generation which is in mathematics teaching in secondary level is well introduced with so many teaching learning strategies by computer. In this

way they are familiar with GeoGebra also. But in the real field, the use of GeoGebra is not effective, behind this there may be so many cause.

A number of research paper has been published on the use of GeoGebra in the context of Nepal as well as on other countries. Some of these paper showed that GeoGebra is more effective tool but some of these showed it was effective but not so more in teaching mathematics. I found less number of researches was done on the topic teaching 'mensuration' for our context. Here based on our own context, this study carried out to examine the effectiveness of GeoGebra in teaching mensuration at grade X.

The teaching learning situation of mathematics is not satisfactory and higher number of students are being failed in mathematics. According to NASA report 2011, the average achievement of students (grade VIII) in mathematics was 43% and that of 2013 shows only 35%. This shows that the achievement in mathematics is in decreasing order. For this, teaching method, teaching materials etc. might be the causes. The improvement in teaching method, proper use of teaching materials, technology based teaching learning activities, management of trained teacher, etc. can play the vital role to increase the average achievement of students in mathematics. Here, I thought that effective use of GeoGebra in teaching mathematics may help in this condition. So, effectiveness of GeoGebra in teaching mensuration at secondary level is problem of my study. Mainly, this study was focused on the following two questions:

- Is there any effect of use of GeoGebra in teaching mensuration at grade X?
- What students think about use of Geogebra software?

Objectives of the Study

The aim of this study was to find out the effectiveness of GeoGebra in teaching mensuration at secondary level. The main objectives of this study were:

1. To find out the effectiveness of GeoGebra in teaching mensuration at grade X
2. To identify the students perception towards the use of Geogebra in teaching mensuration

Hypothesis of the Study

A research hypothesis is a specific, clear, and testable proposition or predictive statement about the possible outcome of a research study. This study is based on a quantitative research design. In quantitative research, hypothesis play the vital role. Moreover, specifying the research hypotheses is one of the most important steps in planning a scientific quantitative research study.

Research Hypothesis. Teaching mensuration through GeoGebra yields effective result in terms of the achievement than the achievement of the students taught through without using GeoGebra.

Statistical Hypothesis. The null and alternative hypothesis were formulated as:

H_0 : The average achievement of the students of experimental group in mathematics is same as that of control group on post- test

H_1 : The average achievement of the students of experimental group in mathematics is higher than that of control group on post- test

i.e. $H_0: \mu_1 = \mu_2$

$H_1: \mu_1 > \mu_2$

where μ_1 and μ_2 are the average achievement of experimental and control group respectively.

Justification of the Study

It is the era of technology. So, research on technology is today's need. My study is related to use of modern technology on the context of teaching learning activities in classroom. The findings of this study would be helpful for teachers, students, parents, educators, researchers, curriculum planners and other stakeholders. Mainly, this study will be beneficial for those schools and students where research had been done. This study had focused on teaching mensuration through a dynamic mathematical software GeoGebra. So, necessarily this study may be helpful for those who want to use this software in teaching and learning activities. Also this research has provided literature for further study. My study identified the perception of students towards the integration of GeoGebra in secondary level course which will be beneficial for curriculum developers in Nepal. Moreover, this will be a part of research which can change the trend of teaching learning activities in Nepal.

Delimitation of the Study

Delimitations are those characteristics that limit the scope and define the boundaries of the research study. Delimitations are in the control of a researcher. Delimiting factors include the choice of objectives, the research questions, variables of interest, the population to investigate etc. More precisely, delimitations are the choices made by the researcher. The delimitation for my study were; pilot test was done in only one school, study area was Kanchanpur district, study was done only in two groups of students of two schools of grade X only, it had covered only

mensuration part of compulsory mathematics of grade X, achievement test and interview schedule were the tools for data collection.

Operational Definition of key Terms

The terminology may differ from discipline to discipline and these have been defined from researcher perspectives depending upon the literature. The operational definition and terminology clarify the meaning of the terms which are used in the study. Some of these terminologies related to this research study are defined as follows:

Achievement. In this study, the term “achievement” is defined as the score obtained by students of experimental group and control group on compulsory mathematics test prepared by the researcher.

GeoGebra. It is a freely available mathematics software program from www.geogebra.org which was designed to combine geometry, algebra and calculus in a single dynamic environment. It was developed by Markus Hohenwarter in 2001/2002 AD as a part of his master’s thesis in Austria. It is very useful to visualize the mathematics in 2D and 3D.

Effectiveness. In this study, the term “effectiveness” is defined as the improvement in students’ achievement.

Mensuration. It is a branch of mathematics in which the concept of perimeter, area and volume of figures/objects are given.

Experimental Group. The group of students which was facilitated by using GeoGebra software.

Control Group. The group of students which was taught by using traditional method of instruction.

Traditional Method of Instruction. In this study, it is a teaching method in which teacher uses chalk/marker, duster, blackboard/ whiteboard, text books where teacher is active and students are passive.

Perception. For this study, the word “perception” means students’ understanding or thought towards the use of GeoGebra software in teaching mensuration.

Chapter II

REVIEW OF LITERATURE

A literature review is a scholarly paper, which includes the current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. Such reviews are secondary sources. Literature reviews are basis for a new research in any area.

Also, review of related literature is essential part of the research because it helps to identify variables relevant to research, to avoid the repetition and synthesis of prior work. It also determines the meaning and relationship among the variables (Singh, 2008). A literature review contains a critical analysis and integration of information from a number of sources as well as a consideration of any gaps in the literature and possibilities for future research. The purpose of reviewing the literature is to identify information that already exists about the topic which is going to be studied. Without reviewing the previous work it is impossible to do a new research.

Thus, we cannot avoid the previous work. These works are the road map for new work. Review of literature helps us to identify the variables to the research, defining the problem, recognizing its significance, suggesting data gathering devices, selection for appropriate study design and sources of data. This chapter includes review of the empirical literature, review of theoretical literature and conceptual frame work for this study.

Review of Empirical Literature

Empirical research is based on observed and measured phenomena and derives knowledge from actual experience rather than from theory or belief. Here, some

articles, thesis are reviewed which are related to use of GeoGebra in teaching mathematics.

Zulnaldi & Zakaria (2012) published a research article entitled “The Effect of Using GeoGebra on Conceptual and Procedural Knowledge of High School Mathematics Students” for the purpose of determining the effect of GeoGebra on conceptual and procedural knowledge of function. The study was done on a total of 124 high school students from Ujung Batu Rokan Hulu, Riau, Indonesia. The treatment group and control group contained 60 and 64 students respectively. The conceptual and procedural knowledge test of function was used to collect the data. The result showed that the treatment group had significantly higher conceptual knowledge compared to control group. The findings of this study had provide schools administration and teachers the opportunity to use GeoGebra software for teaching and learning mathematics.

Acharya (2015) had done a study on the topic “Effectiveness of GeoGebra Software on Mathematics Achievement.” The objectives of this study was to compare the achievement of the students in mathematics by using GeoGebra software with the achievement of students taught without using GeoGebra software and to elicit students’ perception in learning circles using GeoGebra software. He has used pretest- posttest nonequivalent control group design for gathering the data. The research was done selecting two schools purposively of Kathmandu district: namely Panga Secondary School and Jansewa Secondary School taking experimental and control group respectively. The researcher has taken 28 students from class 10 as experimental group and 25 of the same grade as control group. The researcher has taken the students of secondary level of Nepal as the population in his research. He taught both the sample groups for a week and then collected the data from

mathematics achievement test as well as mathematics perception test. He concluded that students in the experimental group have better achievement than control group. Also, students' perception is positive towards using GeoGebra in mathematics learning.

Also, Martin (2016) did a descriptive survey research entitled "Information and Communication Technology Pedagogical Integration in Mathematics Instruction Among Teachers in Secondary Schools in Kenya." On the study 200 mathematics teachers were selected using proportionate stratified sampling technique. Data was collected using questionnaires, interview and observation schedules and collected data was analyzed using descriptive statistics involving computation of frequencies and percentages and inferential statistics that included Pearson correlation and multiple regression analysis. Results of that study showed that there is only a limited use of ICTs in mathematics instruction which is attributed to low self-confidence and incompetence in use of ICTs and inaccessibility to appropriate software materials and technical support. There is need to equip schools with the necessary ICT infrastructure including content specific software and technical support.

Similarly, a study done by Kepceoğlu and Yavuz (2016) on the title "Teaching a concept with GeoGebra: Periodicity of trigonometric functions" with aim to analyze and compare the effect of traditional teaching and the computer assisted mathematics teaching on students' conceptual learning about the periodicity of trigonometric function. The design of the study was quasi- experimental. Researchers had taken 36 students of tenth grade from a public school in Istanbul. Students were divided into two groups (experimental and control). Fifteen days after the instruction period, participants filled in a five questions set. The answers of students were analyzed using descriptive statistics. They concluded that with the aid of computer

mathematics education is more effective on students' learning than traditional mathematics education.

In addition, Martinez (2017) did a research entitled "The Effects of Using GeoGebra on Student Achievement in Secondary Mathematics." The aim of this research was to determine if integrating GeoGebra, an iPad application, would have a positive effect on student understanding of High School Geometry. It was an experimental quantitative study with a nonequivalent pre-test and post-test design using a treatment (i.e. using GeoGebra) and a control group (i.e. not using GeoGebra). During the five-week intervention, the treatment group used GeoGebra while the control group had normal instruction. Independent and paired t-tests were conducted to determine for analyzing the data. The researcher concluded that student scores improved when using the Geogebra; however, not statistically higher than the control group.

Likewise, a quasi- experimental study based on constructivist approach carried out by Joshi (2017) entitled "Students' Achievement in Trigonometry Teaching through GeoGebra" with the aim to investigate the impact on students' achievement in teaching trigonometry through GeoGebra software. Taking all the students of Kirtipur Municipality as population and a total of 42 students from grade nine who were studying optional mathematics from Janasewa Secondary School, Kirtipur, Kathmandu as sample. He divided these students into two groups: experimental and control group consisting 20 and 22 students respectively. He facilitated the experimental group by GeoGebra software and control group by traditional method. Achievement test and interview schedule were used to collect the data. To analyze the data t- test value and descriptive method were used. He concluded that facilitating through GeoGebra software yields better achievement than traditional method of

instruction. Also, the students' response towards the use of GeoGebra software was positive.

Similarly, Gajurel (2018) did his master's degree thesis on "Effectiveness of GeoGebra in Teaching Geometry" for the objectives to compare the achievement of students taught by GeoGebra assist learning method over traditional learning method in teaching geometry and to explore the students' perception about GeoGebra in learning geometry. He selected purposively two schools from Dhading district for his study. The study was based on constructivist approach and used pre- test post- test experimental design. The study was carried out taking the sample of 36 students from both the schools: one school was experimental (16) and another was control (20). All the students of grade ten of Thakre Rural Municipality and Dhunibesi Municipality of Dhading district were taken as the population for the study. Achievement test and questionnaires used to collect the data. He compared the mean of both group and concluded that the experimental group had good performed than the control group. Also, the student has positive attitude about GeoGebra in learning geometry.

Also, Singh (2018) conducted a study entitled "Impact of using GeoGebra Software on Students' Achievement in Geometry: A study at Secondary Level." The objectives of the research was to study the effect of GeoGebra on students' achievement in geometry and to study the difference between the achievement of boys and girls by using GeoGebra in teaching geometry. In this research, researcher had taken the male and female students of class nine of CBSE affiliated English medium school of Bilaspur, (C.G.) as population and 45 students were taken as sample. The sample was selected by the simple random sampling technique. The sample of 45 students consists of 22 male students and 23 female students which were divided into two groups- control and experimental group. Control group consist of 23 students

whereas experimental group consists of 22 students (male and female). The experimental group was subjected to the group taught by using Geogebra software while control group taught by traditional teaching method. The data were collected after 3 weeks of application and analyzed by employing Mann-Whitney U test. The finding of the study showed that the achievement of students taught by Geogebra used-teaching is better than that by traditional teaching method. Also, the implications in the field of education that promote the use of Geogebra as a means of improving geometry teaching at secondary level.

Kandel (2018) did a quasi- experimental study based on Vygotsky's social constructivism entitled "Effectiveness of GeoGebra on Students' Achievement in Analytic Geometry at Secondary Level" selecting two schools purposively from Kathmandu district to investigate the effectiveness of GeoGebra on students' achievement in analytic geometry at secondary level. All the students of Secondary level of Nepal were taken as population and a total of 67 students of grade XI for sample in which 35 for experimental and 32 for control group. The experimental group was taught by using GeoGebra software and control group by traditional method of instruction up to 45 days. For the study, data were collected using mathematics achievement test, class observation note and interview. The researcher had used mean, variance, t- test, F- test, triangulation method to analyze the collected data. He concluded that students, in experimental group performed significantly better than that of control group. Also, the students' perception is positive towards the use of GeoGebra in teaching mathematics.

Moreover, Chalaune (2019) did a research entitled "Effectiveness of GeoGebra in Teaching Mathematics." For the objectives, to find the effectiveness of GeoGebra in teaching mathematics and to analyze the students' perception towards

the use of GeoGebra in teaching mathematics. The research was based on constructivist approach. He has completed the study on a chapter: mensuration of grade nine and used pre- test and post- test non- equivalent experimental design. For data collection, he has selected two private schools purposively of Kirtipur municipality of Kathmandu district, Nepal. Study was done taking the sample of 27 and 21 number of students from experimental and control group respectively. He taught the experimental group by using GeoGebra and control by traditional method. Achievement test and questionnaire were used as the tools of data collection. He compared mean, SD and t- test value of these two groups. He concluded that students in the experimental group outperformed those in the control group. Also, the use of GeoGebra in teaching and learning mathematics promotes the students curiosity on subject matter, makes clear sense and encouraged to the students. He recommended that Geogebra software should be included in school level's computer science.

Furthermore, Thanet (2019) completed his thesis entitled "Effectiveness of GeoGebra Software on Teaching Mensuration and Construction at Secondary Level" with objectives 'to compare the achievement of the students taught by using GeoGebra and conventional method in mensuration and construction' and 'to analyze the view of students on using GeoGebra in teaching mensuration and construction'. The theoretical foundation of this thesis was social constructivism learning theory. The quasi- experimental design has been adopted. All the students of grade X of Nawalparasi (Bardaghat- Susta Purva) district were taken as the population and students of grade X of two schools of this district were taken purposively as sample study. The researcher has taken a total of 75 students in sample in which 37 students for experimental group and 38 for control group. He has used mathematics achievement test and interview schedule as data collection tool. For analyzing and

interpreting the data, researcher has used mean, variance, standard deviation, t- test value and qualitative approach. The researcher concluded that GeoGebra in teaching mensuration and construction is an effective tool and students view towards GeoGebra is positive.

According to above review papers, the use of ICT in mathematics instruction in school is not satisfactory. There is need to equip schools with ICT infrastructure. As the conclusion of these researchers, use of ICT in mathematics teaching is very important but there is lack of such technology in classroom activities. These papers concluded that GeoGebra is an effective tool to teach mathematical concept. GeoGebra software in teaching and learning mathematics promotes the students curiosity on subject matter, makes clear sense and encourages to the students. Also, the use of this software in teaching mathematics is one of the best idea for better achievement. Thus, Geogebra is a means of improving mathematics teaching at secondary level.

The purpose of my study is to find out the effectiveness of Geogebra software in teaching mensuration. In this study, the perception of students towards use of GeoGebra has been identified standing on different questions relating with teaching learning activities. All of the above research papers were helpful for my study. Maximum number of the above papers were carried out on geometrical part of mathematics. My study is also related to geometrical part but particularly it had been done on mensuration topic. Moreover, above research were done taking the sample of different places. The generalization of the result of any study depends on sample size, research area, etc. The population of this study was all the secondary level students of kanchanpur district. So, its generalization area is only that district.

Review of Theoretical Literature

Social constructivist theory which is a learning theory; was developed by a Russian psychologist and philosopher L. S. Vygotsky (1896- 1934). This theory focuses on how a learner can construct his/her knowledge? According to Ernst (1991), social constructivism focuses on questions: how to account for the nature of mathematical knowledge as socially constructed? And, how to give a social constructivist account of the individual's learning and construction of mathematics? (As cited in Thanet, 2019). This is a theory which is based on the idea that learners construct knowledge themselves. This theory takes society as the source of knowledge. According to this theory, learning is primarily taken as a social and cultural process and secondarily it is an individual achievement. This theory has used the terms MKO (more knowledgeable others), ZPD (zone of proximal development) and scaffolding. Here, MKO is a person or peer or society which have more knowledge than a learner who can scaffold (help) to a learner to increase the ability. 'Vygotsky described ZPD as a distance between child's ability in independent problem solving and potential ability of problem solving with guidance' (Burton, 1999). Thus, the term ZPD refers the gap or distance between what a learner can do independently and what he/she can do in joint activity. Similarly, scaffolding refers the dialogic communication between a novice and his/her interlocutor. According to social constructivist learning theory, prior knowledge is important. A prior knowledge is that which a learner has already had. To increase the level of knowledge a learner must actively interact with others/ peers.

Mensuration is one of the main branch of mathematics of secondary level (grade 9 & 10) curriculum of Nepal. In order to teach the mensuration topic in secondary level through GeoGebra software social constructivist learning theory will

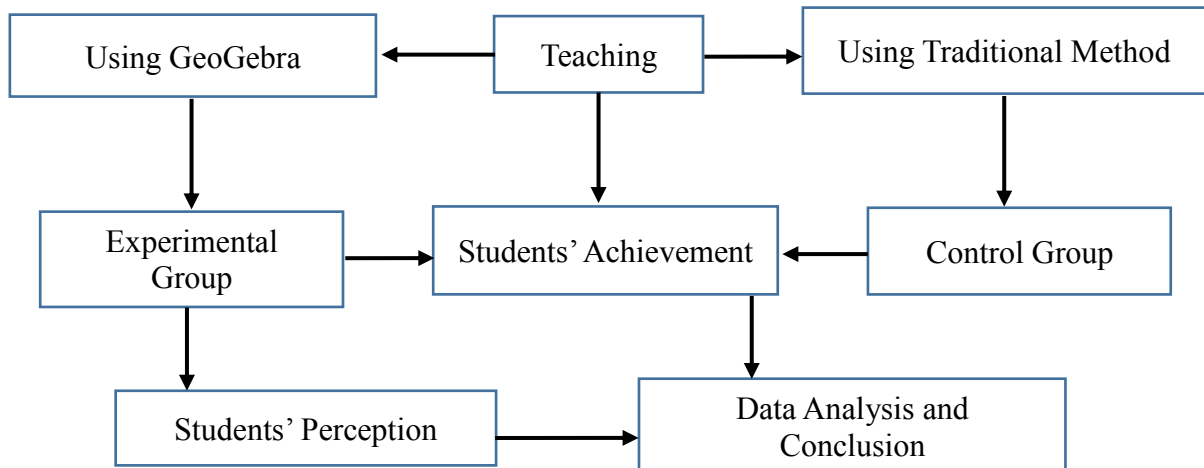
play vital role. So, the theoretical perspective of this study was constructivist theory of learning. Class is a mini society and student is an active learner of that society. The aim of any class is to make students understandable about the topic that will teach. It means that students should know something new from every classes.

In teaching mensuration topic, the use of GeoGebra software can help the students to construct their knowledge because it will create an environment for interaction with peers and facilitator. GeoGebra visualize the learning materials by which it will easy for the students to develop their knowledge. Students generally have challenges in understanding mathematical concepts; therefore in this study the GeoGebra software will be introduced as a scaffold to enhance students' understanding of mensuration. So, GeoGebra will help students to reach their ZPD. Since a constructivist class is student centered. So, there must be an environment of knowledge sharing with peers. Thus, peers and facilitators also play the role on scaffolding to reach in ZPD.

Thus, using GeoGebra software in teaching mensuration teacher will be a facilitator who encourage and motivate students for learning and students will construct their knowledge themselves. Classes will be student centered by which interaction with others will possible.

Conceptual Framework

The conceptual framework of this study is as follows:



Social constructivist learning theory had been taken as the theoretical foundation of this study. In this study, experimental group of students were taught by using GeoGebra software. GeoGebra has play the role for scaffolding which helps to the students to reach their ZPD. But students in control group were taught by traditional method. After treatment of both groups, there was an achievement test for both groups. A sample of students from experimental group was participated in an interview also. Finally, the data obtained from achievement test and interview schedule analyzed and then conclusion was drawn.

Chapter III

METHODS AND PROCEDURES

Research methodology is a science which determines how to complete the research systematically. Methods are tools or techniques applied in the research process and procedures are a way to put tools and techniques together in combinations to achieve objectives. This chapter mainly incorporate with how data will be collected and how it will be analyzed. Specially, it describes; research design, population, sample and sampling strategies; study area/ field, data collection tools and techniques, data collection procedure and data analysis and interpretation procedures.

Design and Method of the Study

According to Singh (2008), the research design is the detailed plan of the whole study. In fact, it is the blue- print of the detailed procedures of performing the experiment, testing the hypothesis, analyzing the obtained data and summarizing the findings. Thus, the research design is the overall plan for the research.

In this research quantitative research design was followed. But some qualitative data has been taken. I have selected the pretest posttest nonequivalent control group design which is one of the quasi- experimental research design. In this study, there were two groups of students of grade X. Moreover, one group was experimental group and another was control group. The experimental group was treated by a mathematical dynamic software GeoGebra and control group of students by traditional method of instruction. I taught these two groups the same content of grade X under the topic ‘mensuration’. The quasi- experimental research design can be diagrammed as below (Best & Kahn, 2009):

Table 1: Design for the study

Groups	Pre- test	Treatment	Post- test
Experimental	O ₁	T ₁	O ₃
Control	O ₂	T ₂	O ₄

Here, O₁ and O₂ represent the pre- test for experimental and control group respectively while O₃ is post- test for experimental group and O₄ is the post- test for control group. Similarly, T₁ and T₂ denote the teaching method of instruction for these two groups. More precisely, T₁ represents the teaching method for experimental group (i.e. new innovation teaching method using a dynamic mathematical software GeoGebra) and T₂ indicates the teaching method for control group (traditional method of instruction).

The marks obtained by students in pre- test was their achievement before treatment and used to measure the similarities between the experimental and control group. After the treatment, a post- test was conducted for both the groups using the same test as used in pre- test. Also, to measure the perception of students towards the use of GeoGebra in teaching mensuration, an interview was conducted for a sample of students from the experimental group only.

Population, Sample and Sampling Strategies

In this study, all students of secondary level of grade X of Kanchanpur district were taken as the population. But it was not possible to study on whole such population due to lack of many resources. So, I have selected two private schools from Kanchanpur district purposively for the sample. These two schools were Modern

Montessori Bal Vidhyalaya (MMBV) and Mahakali Modern Public School (MMPS). Since, there were other institutional and public schools on that locality where selected two schools situated. I was unable to select these other schools for my study because of lack of many resources. Using random sampling method (tossing a coin), students of one school were taken as experimental group and that of another school as control group. Also, a group of five students of experimental group was participated to express their views towards the use of GeoGebra. This group of student consisted the students with poor, average and good scores on achievement test. But some of them were selected on the basis of having computer at home.

Table 2: Composition of Sample

Groups	Number of Students
Experimental	29
Control	23
Total	52

Independent, Dependent and Extraneous Variables

A variable is a characteristic or attribute of an individual or an organization that researcher can measure or observe and varies among individual or organizations studies (Creswell, 2012).

In this study, the independent variable was teaching method using a dynamic mathematical software GeoGebra. And, students' score on mathematics achievement test (post- test) as well as students' perception towards the use of GeoGebra software in teaching mensuration were dependent variables.

Selection of school, selection of teacher/ instructor in both groups, teaching content, time duration, school environment, students' labor, home environment, time duration between pre- and post- test, evaluation system, experiment time, tuition classes of students outside of school were extraneous variables to this study.

Control Mechanism for Extraneous Variables

In this study, except experimental variable (independent variable) which may have significance influence on students' achievement (dependent variable) was controlled as soon as possible. To control such extraneous variables, only two schools were selected, the same instructor/teacher (researcher himself) taught the same content up to three weeks in both groups, the time duration between pre- test and post-test was one month and the same items for achievement test was used in both groups. In this way, these conditions were kept in mind. But some other extraneous variables like home environment, school environment, interaction among students, students' labor, students' tuition classes etc. were not controlled.

Data collection tools

In this study, to collect the data two instruments were used: achievement test and interview schedule.

Mathematics Achievement Test (MAT). Achievement test is an important tool to collect the data for the study. I have developed the achievement test with the help of pilot test and specification grid of compulsory mathematics of grade X developed by CDC Nepal 2075 BS. There were 24 objective questions of weight one mark, eight subjective questions in which four questions each of four marks and remaining four questions each of five marks. In this way there were 32 questions on pilot test and the full marks was 60. But MAT consisted only seven objective

questions, four subjective questions in which two questions each of four marks and remaining two questions each of five marks. Thus, there were only 11 questions on MAT and the full marks was 25. And, the other questions submitted on pilot test were rejected.

Interview Schedule. To identify the perception of students towards the use of GeoGebra in teaching mensuration, an interview schedule was used. Open ended questions for analyzing students' opinion towards the use of GeoGebra in teaching mensuration were used. Interview was conducted taking a sample from experimental group after treatment by GeoGebra software. With the help of supervisor only five open ended questions were selected to conduct interview from a set of open ended questions made by me.

Reliability and Validity of the Tool

Reliability refers to whether or not we get the same answer by using an instrument to measure something more than once. In simple terms, research reliability is the degree to which research method produces stable and consistent results. Similarly, a test is said to valid if it measures what is supposed to measure.

A pilot test was conducted to measure the quality of questions on a group of 31 students of Gyan Batika Boarding School of BDN, Kanchanpur. For standardization the questions, difficulty index (P- value) and discrimination index (D- value) was calculated. Also the coefficient of reliability was 0.71 (Appendix- C) which indicated that it was reliable. After analyzing the items, I have prepared MAT for pre- test and post- test.

For the reliability of interview, respondents were asked the same question repeatedly. Also, questions for an interview schedule was constructed by the judgement of supervisor.

Threats to Validity

An experiment is valid if the results obtained are due to only the manipulated independent variable and if they are generalizable to individuals or contexts beyond the experimental setting (Gay et al., 2012). These two criteria are referred respectively, as the internal and external validity of an experiment which are mentioned below:

Threats to Internal Validity. Internal validity is the degree to which observed differences on the dependent variables are a direct result of manipulation of the independent variable, not some other variables (Gay et al., 2012). In this study, the control mechanism of threats to internal validity is as follows:

Maturation. This study was done in short period of time. So, no more changes occur in participants due to growing older, more experienced etc. which was only possible due to independent variable.

Testing. The time duration between pre- test and post- test was one month. So, the result of pre- test may not affect the result of post- test.

Instrumentation. The item analysis and estimation of reliability of test item was determined through pilot test. Also, MAT tested in both the groups at the period of pre- test and post- test which was same. So, the result was not affected by instrumentation.

Differential Selection of participants. Two groups of students were selected from two schools namely MMBV & MMPS and pre- test was used to check the initial equivalence of the groups.

Mortality. In this study, those students participating only one test either pre- test or post- test was not included for the result of the study.

Threats to External Validity. It is the degree to which study results are generalizable, or applicable, to groups and environments outside of the experimental setting (Gay, et al., 2012). The possible treats that affect the external validity and their control mechanism are mentioned as below:

Experimenter effects. I have tried for my best to control all the extraneous variables. So, there was not produced any experimental change. Also, I taught/ facilitated both the groups for the same duration time and analyze the data without any bias. So, there is possibility of generalizations of this study.

Multiple Treatment Interference. In this study, the experimental group was facilitated the course under the topic ‘mensuration’ by using a mathematical dynamic software GeoGebra and control group of students was taught by traditional method of instruction only. The participants in both the groups did not get more than one treatment.

Intervention

Mensuration topic of grade X was selected for experiment. GeoGebra software was used to teach mensuration in experimental group and traditional method of teaching was used for control group. I taught both the groups up to three weeks. After dividing the groups as control group and experimental group pre- test was administered on both the groups. This test showed that both groups were homogenous. After that, intended classroom activities were implemented. Nineteen

lesson plans were developed to teach up to three weeks. I have constructed these lesson plans (teaching episodes) being based on constructivist approach of learning and following the curriculum of Mathematics of grade X. Lesson planes were finalized (only ten planes are presented in appendix- J) for classroom activities after judgment of expert only. Also, each lesson plan were constructed considering the time separated for mathematics period in each day. I have submitted the steps to construct GeoGebra applets in each teaching episode. Child centered classroom activities were managed in teaching learning activities. Objectives of lesson plan were focused using GeoGebra software in constructivist teaching approach in each classroom activities. With the help of projector, GeoGebra work was demonstrated in classroom. A post-test was administered on both the groups after classroom activities up to nineteen days of teaching using MAT presented in (Appendix- D). Finally, interview was administered only on a sample of experimental group using five open ended questions which are presented in (Appendix- G).

Data Collection Procedures

To collect the data for this study, I have visited two schools MMBV & MMPS of Kanchanpur district. I informed the principals about the study and requested to give the permission. Then, a pre-test was conducted on both the groups using MAT with the help of subject teachers. After the treatment up to three weeks, there was post- test for both groups using the same MAT. At the last, interview was conducted taking a sample of five students from experimental group.

Data Analysis and Interpretation Procedures

In this study, collected data from mathematics achievement test were analyzed by descriptive and inferential statistical methods. In descriptive method, mean,

variance and standard deviation was calculated with the help of Microsoft office Excel 2013 of the score of both groups in pre- test and post- test. To compare the achievement of students in pre- test and post- test, t- test was used. Also, the data collected from interview schedule was analyzed by thematic approach which is helpful to know the perception of students towards the use of GeoGebra in teaching 'mensuration'.

Ethical Consideration

To accomplish this research, some of the important ethical issues were considered. I have taken permission from institutions prior to planning or conducting experiment providing accurate information about research proposal. I will keep the responses of the respondent's confidential. Also, before collecting data, I gave the clear information of my study to the cooperative institutions and participants. I have used appropriate language in my research area all over the time.

Chapter IV

ANALYSIS AND INTERPRETATION OF DATA

This chapter deals with the presentation and interpretation of the collected data with results of the data analysis. In this study data were collected from achievement tests (pre- and post- test) and interview schedule. In this study, achievement test was conducted in both groups (experimental and control groups) but interview was administered taking a sample from experimental group only. The collected data were analyzed by descriptive statistics and inferential statistics. Specially, t- test was used to test for the statistical significance difference between the control and experimental group while descriptive method was used to analyze the data obtained from interview. The analysis and interpretation of the data achieved from tools was analyzed as follows:

Comparison of Achievement of Students on Pre- test

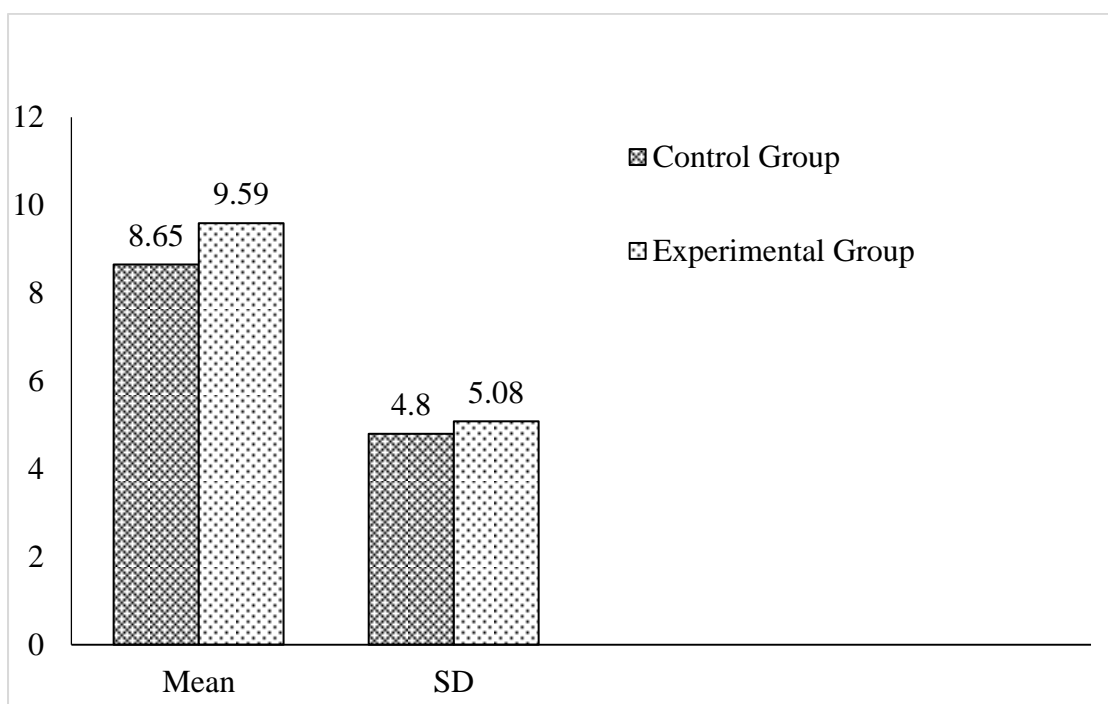
After dividing the groups as control and experimental group, pre- test was conducted within both groups: control and experimental groups. The aim of this test was to find out whether both groups were homogenous in cognitive level or not. The scores obtained by students of both groups in pre- test is presented in ‘Appendix- E’. But, the statistical result of both groups in pre- test is presented in the following table:

Table 3: Result of Pre- test

Group	N	Mean	SD	Variance	Calculated t- value	Level of Significance	Tabulated t- value
Control	23	8.65	4.8	23.04	0.67	0.05	1.96
Experimental	29	9.59	5.08	25.81			

Table no. - 3 shows that the number of students (respondents), mean, standard deviation and variance of the control group and experimental group on pre- test. The total number of students on both the groups were 52, where control group consists 23 students and experimental group consists 29 students. The mean score of control and experimental groups were 8.65 and 9.59 respectively which are very close. Similarly, the standard deviation of control group was 4.80 while that of experimental group 5.08. Also, the variance of control group was calculated as 23.04 and that quantity of experimental group was 25.81 only. Again, calculated t- value was 0.67 while its tabulated value was 1.96 on two tailed at 0.05 level of significance. This shows that there did not exist significant difference between mean achievement of students in control group and experimental group on pre- test. Thus, both groups of students were homogeneous in terms of their achievement. The result (mean and standard deviation) of pre- test of control group and experimental is presented in the following figure:

Figure 1: Result of Control Group and Experimental Group on Pre- test



Comparison of Achievement of Students on Post- test

After pre- test, some treatment was provided to both the groups. Specially, control group was treated by traditional teaching method while experimental group was treated by using a mathematical software GeoGebra up to three weeks. After a month of pre- test one more test (using the same items as in pre- test) was conducted on both the group namely post- test. The marks obtained by individual students in post- test was presented in 'Appendix- F'. But, here I have presented the statistical result of post- test in the following table:

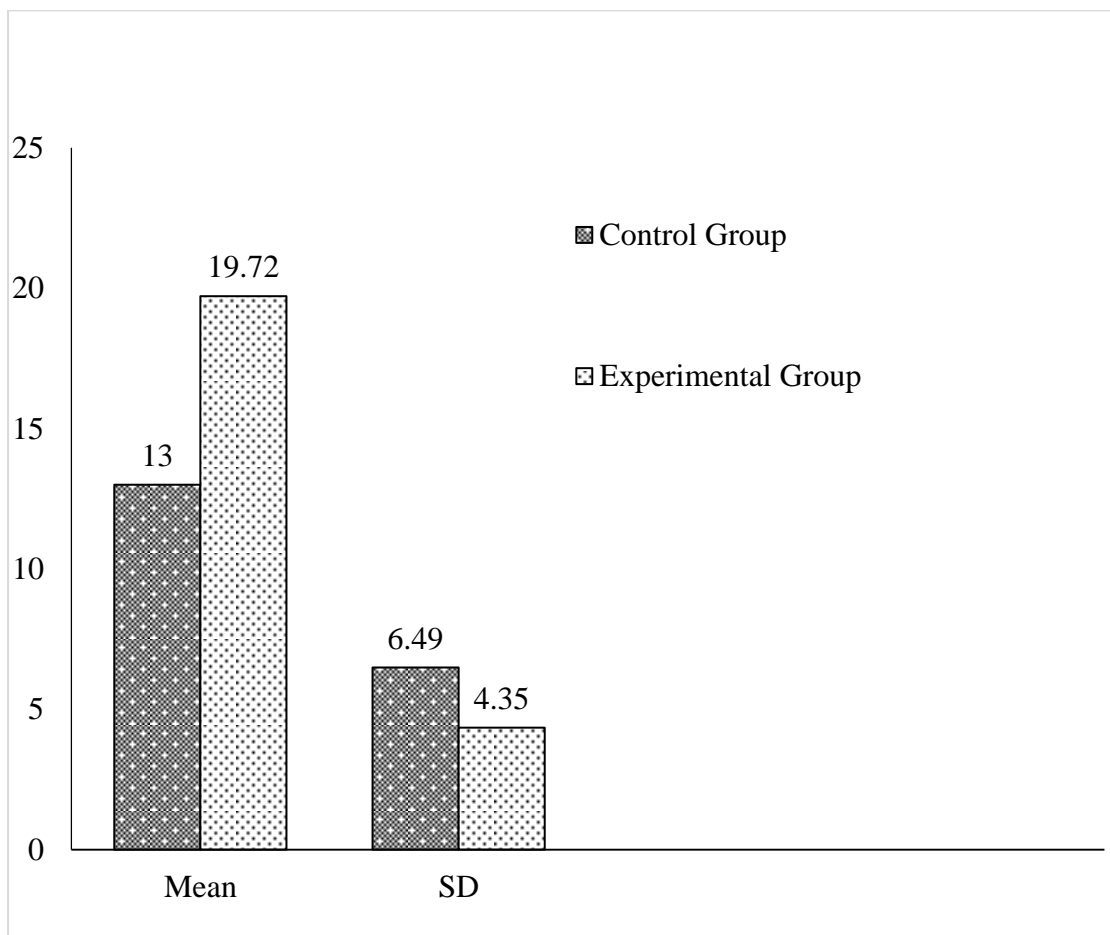
Table 4: Result of Post- test

Group	N	Mean	SD	Variance	Calculated t- value	Level of Significance	Tabulated t- value
Control	23	13	6.49	42.12	4.44	0.05	1.645
Experimental	29	19.72	4.35	18.92			

Above table- 4 shows that the number of students participated in the study, mean scores, standard deviation and variance of control group and experimental group on post- test. The mean score of control group in post- test was 13 where it was of experimental group 19.72. The standard deviation of control and experimental group in post- test were 6.49 and 4.35 respectively. Similarly, the variance of control group was 42.12 and that of experimental group was 18.92. The tabulated and calculated t- values at 0.05 level of significance for one tailed test are 1.645 and 4.44 respectively. This yields that calculated t- value is greater than tabulated t- value. Thus, the null hypothesis (The average achievement of the students of experimental group in mathematics is same as that of control group on post- test) stated in chapter I is

rejected. Consequently, alternative hypothesis (The average achievement of the students of experimental group in mathematics is higher than that of control group on post- test) is accepted. This implies that there is significant difference between the mean achievement of control group and experimental group on post- test. Also, the higher mean score of experimental group than control group indicated that experimental group had greater achievement than control group. This means students who had facilitated using GeoGebra software in teaching ‘Mensuration’ topic had significantly better achievement than the students who had taught by traditional method of instruction. The result (mean and standard deviation) of post- test of control group and experimental group is presented in the following figure:

Figure 2: Result of Control Group and Experimental Group on Post- test



Comparison of Achievement Score of Experimental Group on Pre- test and Post- test

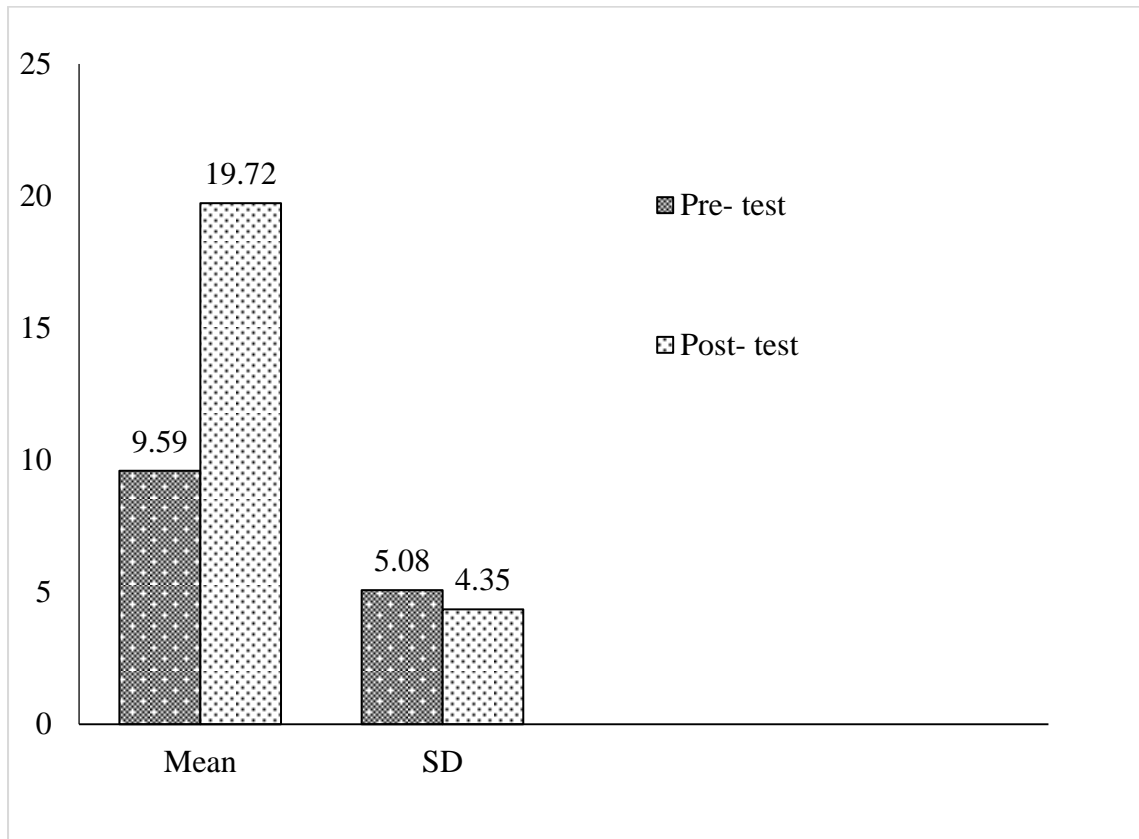
This section will compare the result of pre- test and post- test of experimental group only. The statistical result is presented in the following table:

Table 5: Result of Pre- test and Post- test of Experimental Group

Test	Mean	SD	Variance
Post- test	19.72	4.35	18.92
Pre- test	9.59	5.08	25.81

Above table no. - 5 shows that mean scores, standard deviation and variance of experimental group on pre- test and post- test. The mean score of experimental group on post- test were 19.72 while it was on pre- test 9.59 only. Here, the mean score of experimental group on pre- test is differ by 10.13 than that on post- test. Similarly, the standard deviation of experimental group on post- test and pre- test were 4.35 and 5.08 respectively. Finally, the variance of the same group on post- test and pre- test were 18.92 and 25.81 respectively. Thus, analyzing the above result presented in table no. - 5, it is clear that the average achievement of experimental group on post- test is greater than that on pre- test. Since, post- test was conducted after the treatment i.e. using GeoGebra software. Hence, 'GeoGebra' looks like an effective software in teaching learning of 'Mensuration' for grade X. The result of experimental group on pre- test and post- test is presented in the following histogram:

Figure 3: Result of Experimental Group on Pre- test and Post- test



Students' perception towards learning mensuration using GeoGebra software

The perception of students' towards learning mensuration using GeoGebra software was identified through an interview schedule. Five open ended questions (which are presented in 'Appendix- G') were included in interview schedule and it was conducted among five students of experimental group. To analyze the data collected from in interview schedule thematic approach was used. Being based on students' views on all five open ended questions, following three themes were constructed:

Interaction in Group. Interaction in group is a way of learning something new from each other. For this, there should be a problem to discuss and all the participants take part on discussion in a group actively. It is similar like group discussion.

When I asked the question ‘*what do you do when you unable to solve a mathematical problem? Why?*’ On this statement one of the students put his/her view as below:

“If I am unable to solve a mathematical problem, I discuss with my friends at school. Since, discussion in group is an interesting way to understand a mathematical problem for me. Again, if it is impossible to solve the problem in group then I ask it to my subject teacher.”

Similarly, another student said that, *“I like to discuss with my friends at school to solve mathematical questions. If the discussion is not fruitful then I request to our subject teacher for solution of the question.”*

Also, *“At first I try to solve mathematical problem myself. If I am unable to find the correct solution of any question I ask my friends at class because I believe that when multi- minds focus on a single problem, then solution comes fast and in easy way.”*

Group discussion was the first option of these students’ to solve a mathematical problem. They liked to interact at group and believed that multi- minds give the correct solution of a mathematical problem in short period of time. Finally, if group discussion was not fruitful then only they told the problem to their subject teacher.

But the views of other two students’ on the same statement was a little bit different. They told me that,

“Since no one is there at my home to guide me for mathematical problem. So, generally I ask my difficult mathematical problems to our mathematics teacher.”

Similarly, “*Maximum mathematical questions I can solve myself. But a few number of questions which are very difficult for me then I ask to subject teacher. Our teacher teach the questions in easy way.*”

Although, these two students were using the same method as the method followed by above three students but they asked their mathematical problem to their subject teacher instead on a group. It means they liked to interact with teacher.

From the students’ views mentioned above, it is seen that either they interact in group or they interact with their subject teacher for the mathematical questions which they feel difficult. Being based on their views, interaction was better way of learning mathematics. According to Vygotsky, social interaction plays an important role in the learning process. In this process of learning, the learner having higher ability guide the other learners. Here, the students or teacher who guide the others play the role of MKO (more knowledgeable other). Thus, this interaction is beneficial to increase the ZPD (zone of proximal development) of learners.

Visualization and Understanding. Visual and understanding mean to develop the power to make experience from the formation of mental visual image. In teaching learning activities understanding depends on visualization. Talking more precisely, good visualization for mathematical problem shows better understanding for mathematical solution. It means visualization is very important to understand any mathematical concept.

In the process of data collection, I asked the question ‘*what did you feel in learning mensuration when I used GeoGebra software in teaching mensuration? Why?*’ to the respondents. Then, they replied as follow:

One of the students replied that *“I feel very easy in learning mensuration when you used GeoGebra software in teaching. When you moved figure/ object through GeoGebra it was really interesting. This process made me to understand the figure. I think having good concept of figure make us to solve a geometrical problem.”*

Similarly, *“Sir, I have never seen this type of software to teach mathematics before. It was very easy to calculate CSA, TSA and volume of figure/ object when these were moved left- right and up- down. So, I felt easy in learning mensuration.”*

The another participant replied me as *“The use of Geogebra software in teaching learning mathematics means technology was used in teaching learning activities. Obviously, I felt very interesting learning through GeoGebra.”*

Also, *“Since a 3D object given in a book is very difficult to understand for me. When we were taught through GeoGebra software, I had developed better concept about figure. If we know about figure, then it is very easy to find out the solution of a mensuration problem.”*

And, *“Teaching through GeoGebra was new way of learning mensuration. When you have used this software in teaching mensuration topic, I felt easy to understand the problem. Mainly, I liked movement of figure.”*

Concluding the students’ views on above statement, they simply told me that it was very interesting and funny. They said that the movement of figure made them to develop the concept of figure. Also, it was easy to solve a mathematical problem if they have understand the figure.

Similarly, students’ views on the next statement *‘did you get any differences in learning mensuration with using GeoGebra and before? If you got, in which aspect you got it?’* is presented as below:

“Yes, I got difference in learning mensuration using Geogebra and without using Geogebra. Teaching through GeoGebra helped me to develop the concept of combined objects. Particularly, in calculation of TSA of the combined object made by cone and hemisphere I used to confuse. Here, I mean the TSA of such a combined object is the sum of TSA of separate object or not. But when you taught the same problem using GeoGebra, I got the sum of CSA of cone and hemisphere as TSA of the combined object which was correct. So, I was able to develop clear concept of combined objects.”

Similarly, “I have got so much differences in learning mensuration using GeoGebra and without using GeoGebra. Mainly, I got it on surface area of combined objects, height and slant height of pyramid, cross section, on the problems of rectangular based pyramid (like: slant heights, base lengths) etc.”

Also, “The use of GeoGebra made us to understand the concept of mensuration easily. In particular, it was very simple to understand the figure using GeoGebra.”

Another participant replied me “I also got it. When GeoGebra was not used in learning mensuration, I was unable to solve all the questions but nowadays I can.”

In similar way, “I feel easy nowadays than before in solving mensuration problem. GeoGebra can separate the combined object and combine the separate objects. This made me to understand the figure by which it was easy to solve problems correctly.”

Collecting the students’ views on the above statement, it was found that they got the differences in learning mensuration problems. Mainly, they got it on calculating surface area (CSA and TSA), cross- section, height and slant height etc.

Also, GeoGebra was important to understand the actual meaning of figure for correct solution.

Here being based on students' views on both the statements by demonstrating the figures through GeoGebra software they able to understand the figures. According to them if they have good understanding about the figures then they can solve maximum questions. Thus, it can be said that visualization play the vital role.

There is a famous Chinese proverb "If I hear and I forget. If I see and I can remember. If I do I understand". Using GeoGebra software in teaching mensuration proved the third statement "If I do I understand" of Chinese proverb. Thus, it is clear that GeoGebra played the role of MKO in classroom activities. Also, it was very useful for the active participation of students in learning. Moreover, GeoGebra play the vital role to make the learning student centered.

Use of Technology in Learning. As mentioned before it is the age of science and technology. Every step of human being is affected by the modern technology. Knowingly or unknowingly our live is driven by the technology. Obviously, teaching learning activities may not live far from this technology. Since I have used GeoGebra software in teaching mensuration and GeoGebra is the gift of modern technology. Here, I had tried to understand the students' perception towards GeoGebra being based on the following two questions:

When I asked the question '*do you think that GeoGebra should be used to teach every concept of mathematics? Why?*' one of the students replied me as:

"It will better if GeoGebra is used to teach other geometrical concept of mathematics. Because in geometrical part, we must have the actual concept of figure. To understand the figure GeoGebra is important."

Similarly, *“Yes, it should be used in teaching learning activities of other concept of mathematics because it helps the students to understand the subject matter in different way. Mainly, it should be used in teaching theorems, experimental verifications. These geometrical concepts are very difficult as we all know.”*

Also, *“I think, the use of GeoGebra in other concept of mathematics will be fruitful. For example: theorems, out theorems, experimental verifications, construction of geometrical figures, etc. are difficult areas of mathematics. If modern technology is used to teach these concepts, obviously it will be better.”*

Another student said that, *“Yes, it will better for students and teacher if GeoGebra is used in other geometrical parts of mathematics. In short period of time we can understand the solution if GeoGebra is used in teaching.”*

Also, next participant told me, *“Mainly GeoGebra software helped us to understand the geometrical figures. If we have the knowledge of figure, then there is maximum chance of solving the problem. So, GeoGebra should be used in teaching other concept of mathematics.”*

The views of students on the above question indicated that GeoGebra is essential for teaching learning geometrical part of mathematics but not all concepts of mathematics. They had focused the use of GeoGebra on teaching theorems, experimental verifications, construction based questions, mensuration, etc. Also, they said that they can develop more concept of subject matter in a short period of time with the help of GeoGebra. GeoGebra is important for long lasting learning also. Thus, GeoGebra would be fruitful if it was used in other concept of mathematics.

As a last question, *‘what is your position (favor or opposition) on ‘GeoGebra should be a learning part of mathematics’? Why?’* was asked to the respondents.

One of them replied as *“I am in favor because GeoGebra software is important in learning the geometrical part of mathematics but not only in teaching. If we have the knowledge of this software we can solve many problems ourselves.”*

Also, *“Yes, GeoGebra should be a learning part of mathematics. I think this software is helpful for self-study also.”*

In the similar way, another student told as *“In geometrical part, it is necessary to understand the figures for correct solution. Obviously, GeoGebra is such a software which clears the concept of 2D, 3D figures. So, the knowledge of GeoGebra can help us in learning mathematics. So, I am in the favor of ‘Geogebra should be a learning part of mathematics.’”*

A next student’s view was *“GeoGebra is a part of modern technology. The use of technology in learning new thing is very helpful for us. Thus, the knowledge of GeoGebra also helpful in learning mathematics. So, I am in favor of it.”*

Finally, *“It is very easy to learn mathematics by using GeoGebra. So, the knowledge of Geogebra is helpful in learning mathematics. Thus, it should be the learning part of mathematics.”*

These students’ views on last question indicated that they were in the favor of GeoGebra i.e. GeoGebra should be a learning part of mathematics. They claimed that GeoGebra is a part of modern technology and having the knowledge of GeoGebra is very helpful to develop the knowledge of mathematics.

From the views of students on last two questions it is clear that technology affects the learning. It is seen that Geogebra is important for teaching learning process. Mainly, GeoGebra is essential software for geometrical part of mathematics. Also, having knowledge of GeoGebra software may be helpful for self-study also.

Thus, Geogebra is useful to interact for students and they can develop their knowledge themselves using this software as Vygotsky's theory described that learner develop their knowledge themselves interacting in society.

Chapter V

FINDINGS, CONCLUSION AND RECOMMENDATION

This chapter deals with the findings, conclusion and recommendation of the study.

Findings of the Study

On the basis of the data obtained from achievement test and interview schedule, it was found that:

- The average achievement of control group and experimental group in pre- test was 8.65 and 9.59 respectively. This implies that the average achievement of experimental group was more than that of control group by 0.94.
- The result of pre- test showed that the calculated t- value was 0.67 while tabulated t- value (two tailed) at 0.05 level of significance was 1.96. This implies that there was no significant difference between control group and experimental group on mathematical average achievement. Hence, both groups were assumed homogeneous for the further study.
- The average achievement of control group and experimental group in post- test was 13 and 19.72 respectively. This implies that the average achievement of experimental group was more than that of control group by 6.72.
- The result of post- test showed that the calculated t- value was 4.44 while tabulated t- value (one tailed) at 0.05 level of significance was 1.645. Clearly, calculated t- value is greater than tabulated t- value i.e. $4.44 > 1.645$. Thus, the null hypothesis is rejected and then alternate hypothesis is accepted. This implies that experimental group of students has greater achievement than that of control group.

- The result of experiment group on pre- test and post- test showed that their average achievement was 9.59 and 19.72 respectively. This implies that there was improvement in post- test than in pre- test.
- Technology based teaching learning activities motivate the students to participate in learning actively.
- It is seen that most of the students liked the mensuration lesson when GeoGebra software was used in teaching learning activities.
- Interview with students showed that GeoGebra made the situation to interact in group.
- Furthermore, the data collected from interview schedule showed that students' perception towards GeoGebra in teaching mensuration was positive.

Conclusion

The purpose of this study was to examine the effect of use of GeoGebra software in teaching mensuration at secondary level. The result of post- test of this study showed that average achievement of students of experimental group was far better than that of control group. Since, experimental group was treated by a dynamic mathematical software GeoGebra but control group was taught by traditional method of instruction. It was found students of experimental group were active and the whole class was silent while using GeoGebra in classroom to teach mensuration and they took the part in teaching learning activities actively than those of control group. Also, students' views towards use of GeoGebra was positive. Students were in the favor of GeoGebra and they felt the use of GeoGebra in geometrical part of mathematics would be fruitful. Also, students of experimental group claimed that it is very important to develop the concept about figure and for sustainable learning. Based on

the results and views about GeoGebra it is concluded that GeoGebra is an effective mathematical software in teaching mensuration.

Furthermore, for self- study and long- term learning technology based activities are necessary in classroom of every student. To adjust in modern society we need to increase the use of technological activities in school and home also. In teaching mathematics we can use many ICT based software such as GeoGebra, Mathematica, Mat Lab, etc. The use of these software is necessary to make mathematics as easy subject by teaching it meaningfully. This work is helpful to develop the positive attitude towards the whole mathematics.

Recommendation

As we all know that we are in 21st century which is the era of post modernism. It is also said that it is the age of modern technology. All our activities are affected by technology. There is no any field where technology is not used. We can save our time, money, energy etc. by using modern technology in our work site. Also, for correct and fine result we use it.

Education sector is also affected by modern technology. In teaching learning activities we are using so many software, applications, etc. In teaching mathematics also we can use so many innovations of science and technology. Here, this study carried out to examine the effect of use of GeoGebra software in teaching. Since the result of any research paper is useful for other areas also. The data and result of this study can be used in teaching learning mathematics and in other related areas. The conclusion of this research paper is that GeoGebra is an effective mathematical software in teaching learning mensuration for secondary level. Moreover, the GeoGebra assist instruction yields better achievement and encourage the students in learning mensuration than traditional method of instruction. Thus, technology based

instructions are essential for our context to improve the current achievement of students.

Recommendation for Implication. Here, some recommendations for the educational implications are mentioned as follows:

- Our classrooms should be developed physically by which we can use technology for teaching learning activities
- Mathematics teachers should be given training, organize seminars, workshop etc. about the proper use of mathematical software like GeoGebra, Mathematica, etc.
- ‘Computer’ should be a core subject to make the mathematical software like GeoGebra as learning part of secondary level students
- Mathematics laboratory should be established in each school including ICT tools like GeoGebra

Recommendation for Further Research. Since this study was conducted in two intuitional schools taking two groups of students only in a short period of time due to insufficient resources and lack of time. Other research can conduct taking more sample and for a long time by which the research will give more accurate result about effectiveness of GeoGebra software. Also, this study has taken the sample from grade ten only but new researcher can use it on other grades as well as other levels. Being based on this study, I have made the following recommendations for the further study:

- Further study can be carried out by taking large samples from private and public schools of Nepal and up to long time
- It is recommended to find out and compare the average achievement of boys and girls

- Further study can be carried out on other topics of mathematics
- It is recommended that other grades and levels can be used to examine the effect of GeoGebra in teaching learning

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Appendices

Appendix- A

Item Analysis of Objective Questions

Sts. Item	Upper 27% students who have given correct answer										Lower 27% students who have given correct answer										C	P%	D	Re.
	1	2	3	4	5	6	7	8	T	1	2	3	4	5	6	7	8	T						
1	1	1	1	1	0	0	0	1	5	1	0	0	0	0	0	0	0	1	13	46.43	0.5	A		
2	0	1	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	7.143	0.25	R		
3	1	1	1	1	1	1	1	1	8	0	1	0	0	0	0	0	0	1	15	53.57	0.88	A		
4	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	3	10.71	0	R		
5	1	1	1	1	0	0	1	0	5	0	0	0	0	0	0	0	0	0	7	25	0.63	R		
6	1	1	0	0	1	1	0	0	4	0	0	0	0	0	0	0	0	0	7	25	0.5	R		
7	1	1	1	1	1	1	1	1	8	0	0	0	0	0	0	0	0	0	14	50	1	A		
8	1	1	1	1	0	0	1	1	6	1	1	1	0	0	0	0	0	3	18	64.29	0.38	A		
9	1	1	1	1	0	1	1	0	6	0	0	0	0	0	0	0	0	0	6	21.43	0.75	R		
10	0	1	0	0	1	0	1	0	3	0	0	0	0	0	0	0	0	0	8	28.57	0.38	R		
11	1	1	1	0	1	1	0	0	5	0	0	0	0	0	1	0	0	1	8	28.57	0.5	R		
12	1	1	1	0	1	0	0	1	5	0	0	0	0	0	0	0	0	0	7	25	0.63	R		
13	1	1	1	1	0	1	0	1	6	0	0	1	1	1	0	0	1	4	16	57.14	0.25	A		
14	1	0	1	0	1	0	1	0	4	0	0	1	1	0	1	0	0	3	8	28.57	0.13	R		
15	0	0	1	1	0	0	0	0	2	1	0	0	1	1	0	1	1	5	10	35.71	-0.4	R		
16	1	1	0	1	1	1	1	1	7	1	1	1	0	1	0	1	0	5	19	67.86	0.25	A		
17	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	7.143	0.13	R		
18	1	0	1	0	0	1	1	0	4	0	0	0	0	0	0	0	0	0	7	25	0.5	R		
19	0	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	5	17.86	0.25	R		
20	1	1	0	1	1	0	0	0	4	0	1	0	0	0	0	0	0	1	7	25	0.38	R		
21	1	1	1	1	1	0	1	1	7	0	1	1	0	0	0	0	0	2	19	67.86	0.63	A		
22	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	3	10.71	0.13	R		
23	0	0	1	0	1	0	0	1	3	1	0	0	0	0	1	0	0	2	10	35.71	0.13	R		
24	1	1	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	1	6	21.43	0.13	R		
T	17	16	14	12	12	10	10	10		6	5	5	4	3	3	2	2							

Degree	Meaning
less than 0.19	Negligible
0.20 - 0.29	General
0.30 - 0.39	Good
0.40 - 1	Very Good

Interpretation criteria

for P

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Indicator	Meaning
0 – 39	Very Difficult
40 – 60	General
61 – 75	Substantial
76 – 90	Easy
91 - 100	Very Easy

Source: Ebel and Frisbie, 1991, p. 132 (as cited in Khanal et al., 2071, p.268- 268)

Note: - P = Difficulty level of item, D = Discrimination index, T = Total,

C = Correct answer,

A = Accepted and

R = Rejected

Appendix- B

Item Analysis of Subjective Questions

Student Item	Upper 27% Students									Lower 27% Students									C	P%	D	Re.
	1	2	3	4	5	6	7	8	T	1	2	3	4	5	6	7	8	T				
1	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	0	7	30	96.77	0.13	R
	1	1	1	1	1	1	1	1	8	1	1	1	1	1	1	1	0	7	30	96.77	0.13	
	1	1	1	1	1	1	1	1	8	1	1	1	0	0	1	0	0	4	27	87.1	0.5	
	0	1	1	1	1	0	0	1	5	1	1	1	0	0	0	0	0	3	21	67.74	0.25	
Total	3	4	4	4	4	3	3	4	29	4	4	4	2	2	3	2	0	21	108	87.1	0.25	R
2	1	1	1	1	1	1	1	1	8	1	1	0	1	0	1	0	0	4	26	83.87	0.5	A
	1	1	1	1	1	1	1	1	8	1	0	0	0	0	0	0	0	1	21	67.74	0.88	
	1	1	1	1	1	1	1	1	8	0	0	0	0	0	0	0	0	0	19	61.29	1	
	1	1	1	1	1	1	1	1	8	0	0	0	0	0	0	0	0	0	17	54.84	1	
Total	4	4	4	4	4	4	4	4	32	2	1	0	1	0	1	0	0	5	83	66.94	0.84	A
3	0	0	0	0	1	1	1	1	4	1	0	1	0	0	0	0	0	2	18	58.06	0.25	R
	0	0	0	0	1	1	1	1	4	0	0	0	0	0	0	0	0	0	6	19.35	0.5	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3.226	0	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3.226	0	
Total	0	0	0	0	2	2	2	2	8	1	0	1	0	0	0	0	0	2	26	20.97	0.19	R
4	1	1	1	1	1	1	1	1	8	0	1	1	1	1	1	1	0	6	21	67.74	0.25	A
	1	1	1	1	1	1	1	1	8	0	1	1	1	1	1	0	0	5	20	64.52	0.38	
	1	1	1	1	1	1	1	1	8	0	1	1	1	1	1	0	0	5	20	64.52	0.38	
	1	1	1	1	1	1	1	1	8	0	1	1	1	1	1	0	0	5	20	64.52	0.38	
Total	4	4	4	4	4	4	4	4	32	0	4	4	4	4	4	1	0	21	81	65.32	0.34	A
5	1	1	1	1	1	1	1	1	8	1	0	1	0	0	0	1	0	3	24	77.42	0.63	A
	1	1	1	1	1	1	1	1	8	1	0	0	0	0	0	1	0	2	23	74.19	0.75	
	1	1	1	1	1	1	1	1	8	1	0	0	0	0	0	1	0	2	23	74.19	0.75	
	1	1	1	1	1	1	1	1	8	1	0	0	0	0	0	1	0	2	23	74.19	0.75	
	1	1	1	1	1	1	1	1	8	1	0	0	0	0	0	1	0	2	20	64.52	0.75	
	Total	5	5	5	5	5	5	5	5	40	5	0	1	0	0	0	5	0	11	113	72.9	
6	1	0	0	0	1	1	1	1	5	1	1	1	1	0	1	0	0	5	22	71.45	0.74	R
	0	0	0	0	1	1	1	0	3	0	0	0	1	0	0	0	0	1	5	16.13	0.25	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Total	1	0	0	0	2	2	2	1	8	1	1	1	2	0	1	0	0	6	27	17.52	0.2				
7	1	1	1	1	1	1	1	1	8	0	1	0	1	1	1	0	0	4	23	74.19	0.5				
	1	1	1	1	1	1	1	1	8	0	1	0	0	1	0	0	0	2	20	64.52	0.75				
	1	1	1	1	1	1	1	1	8	0	1	0	0	1	0	0	0	2	19	61.29	0.75				
	1	1	1	1	1	1	1	1	8	0	0	0	0	1	0	0	0	1	18	58.06	0.88				
	1	0	0	0	1	1	1	1	5	0	0	0	0	0	0	0	0	0	13	41.94	0.63				
Total	5	4	4	4	5	5	5	5	37	0	3	0	1	4	1	0	0	9	93	60	0.7	A			
8	1	1	1	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	12.9	0.5				
	1	1	1	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	12.9	0.5				
	1	1	1	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	12.9	0.5				
	1	1	1	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	12.9	0.5				
	1	1	1	1	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	12.9	0.5				
Total	5	5	5	5	0	0	0	0	20	0	0	0	0	0	0	0	0	0	20	12.9	0.5				
Grand																									
Total	27	26	26	26	26	25	25	25	206	13	13	11	10	10	10	8	0	75	551						

Note: - The word meaning and interpretation for D as well as interpretation criteria for P for subjective items are same as that of objective items (Appendix- A)

Appendix- C

Computations of Reliability Coefficient

SN	Scores on odd items (X)	Scores on even items (Y)	X ²	Y ²	XY
1	13	2	169	4	26
2	15	3	225	9	45
3	7	7	49	49	49
4	14	18	196	324	252
5	6	8	36	64	48
6	8	7	64	49	56
7	16	8	256	64	128
8	10	19	100	361	190
9	2	7	4	49	14
10	5	7	25	49	35
11	19	3	361	9	57
12	10	6	100	36	60
13	108	83	11664	6889	8964
14	26	81	676	6561	2106
15	113	27	12769	729	3051
16	93	20	8649	400	1860
	$\sum X = 465$	$\sum Y = 306$	$\sum X^2 = 35343$	$\sum Y^2 = 15646$	$\sum XY = 16941$

$$\begin{aligned} \text{Correlation Coefficient } (r_{XY}) &= \frac{N \sum XY - \sum X \sum Y}{\sqrt{N \sum X^2 - (\sum X)^2} \sqrt{N \sum Y^2 - (\sum Y)^2}} \\ &= \frac{16 \times 16941 - 465 \times 306}{\sqrt{16 \times 35343 - (465)^2} \sqrt{16 \times 15646 - (306)^2}} \\ &= 0.55 \end{aligned}$$

$$\begin{aligned} \text{Now, reliability coefficient } (r) &= \frac{2r_{XY}}{1+r_{XY}} \\ &= \frac{2 \times 0.55}{1+0.55} \\ &= 0.7096 \end{aligned}$$

\therefore Reliability coefficient (r) = 0.71

Appendix- D

Test Items for Pre- test and Post- test

Objective Questions

School:

Subject: Mathematics

Full Marks: 25

Class: 10

Time: 45 min.

Date: -

Roll No.:

Student's Name:

Group A [7 × 1 = 7]

Read the questions carefully then tick (✓) the correct answer.

1. If 'a' be the length of equal sides and 'b' be the length of remaining side of an isosceles triangle, then which of the following formula is used to calculate its area?

a) $\frac{b}{4} \sqrt{4a^2 - b^2}$ b) $\frac{a}{4} \sqrt{4b^2 - a^2}$ c) $\frac{b}{4} \sqrt{4b^2 - a^2}$ d) $\frac{a}{4} \sqrt{4a^2 - b^2}$

2. What is the volume of a hemisphere having radius 'r' unit?

a) $2\pi r^2$ b) $\frac{2}{3}\pi r^2$ c) $\frac{2}{3}\pi r^3$ d) $\frac{4}{3}\pi r^3$

3. If the side lengths of a triangle is 8 cm, 4 cm and 5 cm, then what is its semi perimeter?

a) 8.5 cm b) 17 cm c) 10 cm d) 16 cm

4. A 'h' unit high cylindrical can has radius 'r' units. What is its TSA?

a) $2\pi r + 2\pi rh$ b) $2\pi r (r + 2h)$ c) $\pi r (r + h)$ d) $2\pi r (r + h)$

5. The radius of a sphere is 3 cm. Then its volume is ...

a) $18\pi \text{ cm}^3$ b) $108\pi \text{ cm}^3$ c) $54\pi \text{ cm}^3$ d) $36\pi \text{ cm}^3$

6. The perimeter of base of a triangular prism is 36 cm and its length is 10 cm.

Then area of its lateral faces is ...

- a) 180 cm^2 b) 360 cm^2 c) 468 cm^2 d) 720 cm^2

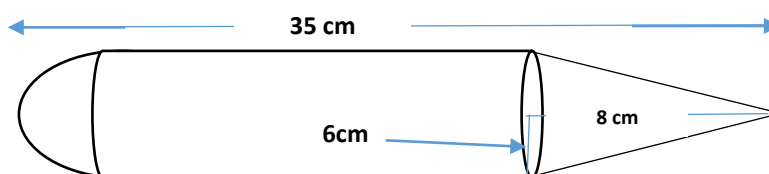
7. How many triangular surface(s) are there in a rectangular based pyramid?

- a) 3 b) 4 c) 5 d) 1

Subjective Questions

Group B [2 × 4 = 8]

8. Find TSA of the combined object made by hemisphere, cylinder and cone which is given alongside?

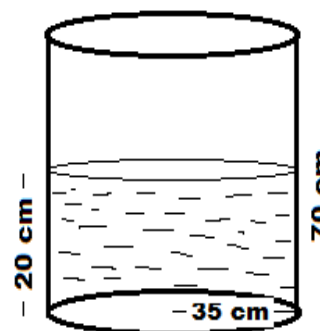


9. Find volume of a square based pyramid having side length 8 cm and slant height 5 cm?

Group C [2 × 5 = 10]

10. A hemispherical bowl with radius 5 cm is completely filled with water. If the water is poured into a right circular conical vessel with diameter 10 cm to fill it completely, then find the height of the level of water in the conical vessel.

11. The adjoining cylindrical vessel is 70 cm high and radius of its base is 35 cm. If it contains some water up to the height of 20 cm, then how much water (in liter) is required to fill the vessel completely?



GOOD LUCK

Appendix- E
Score on Pre Test

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

Appendix- F
Score on Post Test

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

Appendix- G

Interview Schedule

1. What do you do when you are unable to solve a mathematical problem? Why?
2. What did you feel in learning mensuration when I used GeoGebra software in teaching mensuration? Why?
3. Did you get any differences in learning mensuration with using GeoGebra and before? If you got, in which aspect you got it.
4. Do you think that GeoGebra should be used to teach every concept of mathematics? Why?
5. What is your position (favor or opposition) on 'GeoGebra should be a learning part of mathematics'? Why?

Appendix- H

Some Statistical Formulae

1. Mean (\bar{X}) = $\frac{\sum X}{N}$
2. Variance (s^2) = $\frac{\sum f(X-\bar{X})^2}{N} - \left(\frac{\sum f(X-\bar{X})}{N}\right)^2$
3. Standard Deviation (σ) = $\sqrt{\frac{\sum f(X-\bar{X})^2}{N} - \left(\frac{\sum f(X-\bar{X})}{N}\right)^2}$
4. T- distribution (T) = $\frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{s \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$
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. Reliability coefficient (r) = $\frac{2r_{XY}}{1+r_{XY}}$
7. Difficulty Level of Item (P%) = $\left(\frac{R}{T} \times 100\right) \%$
8. 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 students on upper and lower 27 % of students.

Appendix- I

Pilot Test

Objective Questions

School: -

Subject: Mathematics

Full Marks: 60

Class: 10

Time: 2 hrs.

Date: -

Roll No.:

Student's Name:

Group A [24×1 = 24]

Read the questions carefully then tick (✓) the correct answer.

1. If 'a' be the length of equal sides and 'b' be the length of remaining side of an isosceles triangle, then which of the following formula is used to calculate its area?

b) $\frac{b}{4} \sqrt{4a^2 - b^2}$ b) $\frac{a}{4} \sqrt{4b^2 - a^2}$ c) $\frac{b}{4} \sqrt{4b^2 - a^2}$ d) $\frac{a}{4} \sqrt{4a^2 - b^2}$

2. Which of the following formula is used to calculate cross sectional area of a cylinder having height 'h' units and radius 'r' units?

a) $2\pi rh$ b) $\pi r^2 h$ c) πr^2 d) $2\pi r(r + h)$

3. What is the volume of a hemisphere having radius 'r' unit?

b) $2\pi r^2$ b) $\frac{2}{3}\pi r^2$ c) $\frac{2}{3}\pi r^3$ d) $\frac{4}{3}\pi r^3$

4. Which of the following formula is used to calculate curved surface area of a cone having radius 'x' unit, slant height 'y' unit and vertical height 'z' unit?

a) πxz b) πyz c) $2\pi xy$ d) πxy

5. In a triangle, the length of sides are 15 cm and 12 cm and 9 cm. Which one of the following is the area of this triangle?
- a) 90 cm^2 b) 54 cm^2 c) 67.5 cm^2 d) 36 cm^2
6. The area of an equilateral triangle is $\sqrt{3}$ sq. unit. What is the side length of this triangle?
- a) $\sqrt{3}$ unit b) 3 unit c) $\sqrt{2}$ unit d) 2 unit
7. If the side lengths of a triangle is 8 cm, 4 cm and 5 cm, then what is its semi perimeter?
- a) 8.5 cm b) 17 cm c) 10 cm d) 16 cm
8. 'h' unit high cylindrical can has radius 'r' units. What is its TSA?
- a) $2\pi r + 2\pi rh$ b) $2\pi r (r + 2h)$ c) $\pi r (r + h)$ d) $2\pi r (r + h)$
9. The length and breadth of a surface obtained by cutting a cylinder vertically are 10 cm and 14 cm respectively. What is the curved surface area of this cylinder?
- a) 140 cm^2 b) 440 cm^2 c) 740 cm^2 d) 748 cm^2
10. What is the radius of the hemi- sphere having volume $\frac{9\pi}{4} \text{ cm}^3$?
- a) 4.5 cm b) 1.1 cm c) 1.5cm d) 3 cm
11. If the surface area of a sphere is $324 \pi \text{ cm}^2$, then what is its length of radius?
- a) 9 cm b) 36 cm c) 27 cm d) 18 cm
12. The circumference of great circle is 44 cm. Then its radius is...
- a) 3.74 cm b) 7 cm c) 6 cm d) 14 cm
13. The radius of a sphere is 3 cm. Then its volume is ...
- a) $18 \pi \text{ cm}^3$ b) $108 \pi \text{ cm}^3$ c) $54 \pi \text{ cm}^3$ d) $36 \pi \text{ cm}^3$
14. The radius of a great circle is 3.5 cm. What is the volume of hemisphere?
- a) 89.83 cm^3 b) 197.67 cm^3 c) 179.67 cm^3 d) 98.83 cm^3

15. The sum of area of two triangular surfaces of a triangular prism is 12 cm^2 and its volume is 36 cm^3 . Then its length is...
- a) 3 cm b) 3.5 cm c) 6 cm d) 6.5 cm
16. The perimeter of base of a triangular prism is 36 cm and its length is 10 cm. Then area of its lateral faces is ...
- b) 180 cm^2 b) 360 cm^2 c) 468 cm^2 d) 720 cm^2
17. The base area of a square based pyramid is 24 cm^2 and its height is 5 cm. Its volume is
- a) 80 cm^3 b) 24 cm^3 c) 120 cm^3 d) 40 cm^3
18. What is the TSA of a square based pyramid having base length 6 cm and height 4 cm?
- a) 96 cm^2 b) 60 cm^2 c) 30 cm^2 d) 66 cm
19. What is the volume of a cone having radius 6 cm and slant height 10 cm?
- a) $288 \pi \text{ cm}^3$ b) $96 \pi \text{ cm}^3$ c) $36 \pi \text{ cm}^3$ d) None of ab
20. The CSA and TSA of a cone are 175π sq. units and 224π sq. units respectively, then radius of cone is...
- a) 7 sq. units b) 3.5 units c) 7 units d) 14 units
21. How many triangular surface(s) are there in a rectangular based pyramid?
- b) 3 b) 4 c) 5 d) 1
22. If 'x' and 'y' be the radius and height of a cone respectively, then what is its CSA?
- a) πxy b) $\pi x \sqrt{x^2 - y^2}$ c) $\pi \sqrt{x^2 + y^2}$ d) $\pi x \sqrt{x^2 + y^2}$
23. Three spheres having radius r_1 , r_2 and r_3 are melted and formed a single sphere. What is the radius of newly formed sphere?
- a) $\sqrt[3]{r_1^3 + r_2^3 + r_3^3}$ b) $\sqrt[2]{r_1^3 + r_2^3 + r_3^3}$

$$c) \sqrt[2]{d_1^3 + d_2^3 + d_3^3}$$

$$d) \sqrt[3]{d_1^3 + d_2^3 + d_3^3}$$

24. If 'C' cm is circumference and 'S' cm is sum of radius and height of a cylinder respectively, then its CSA is

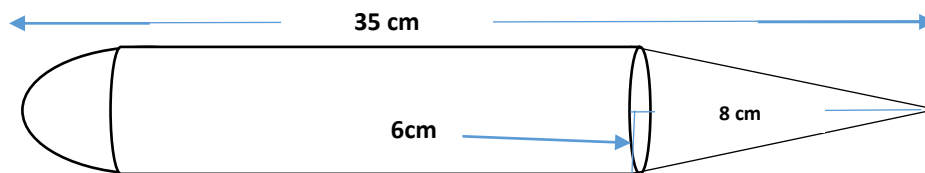
- a) 2CS b) C + S c) CS d) None of above

Subjective Questions

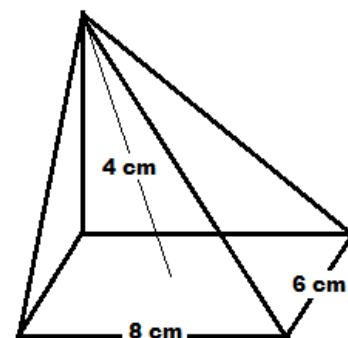
Group B [4×4 = 16]

25. A cylindrical water tank contains 385000 litres of water. If its height is 10m, then calculate its CSA.

26. Find TSA of the combined object made by hemisphere, cylinder and cone which is given alongside?



27. Find the TSA of pyramid which is given alongside.

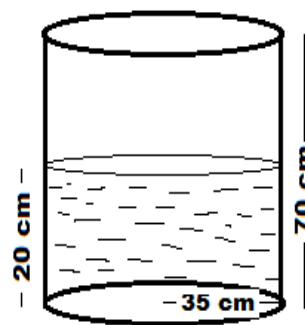


28. Find volume of a square based pyramid having side length 8 cm and slant height 5 cm?

Group C [4×5 = 20]

29. A hemispherical bowl with radius 5 cm is completely filled with water. If the water is poured into a right circular conical vessel with diameter 10 cm to fill it completely, then find the height of the level of water in the conical vessel.
30. A cylindrical log is cut off vertically through its height from the middle of the circular base. If the height of log is 20 cm and radius is 14 cm, then what is the TSA of each pieces of log?

31. The adjoining cylindrical vessel is 70 cm high and radius of its base is 35 cm. If it contains some water up to the height of 20 cm, then how much water (in liter) is required to fill the vessel completely?



32. A cylindrical tub of radius 16 cm contains water to a certain depth. When a spherical ball is dropped into the tub, the level of water is raised by 9 cm. What is the diameter of the ball?

GOOD LUCK

Appendix- J

Sample of Teaching Episodes

Teaching Episode: 01

Subject: Mathematics	Time: 40 min.
Unit: Mensuration	Period:
Topic: Area of Triangle	No. of Students: ...
Grade: 10	Date:
School: -	

1. Specific Objectives:

At the end of this class, students will be able to

- a) Classify the types of triangle on the basis of sides
- b) Find the perimeter, semi- perimeter and area of triangles.

2. Teaching Learning Materials:

- a) Offline sources: GeoGebra applet on “Area of Triangle”
- b) Online sources:

3. Teaching Learning Activities:

Following activities will be done during the class period:

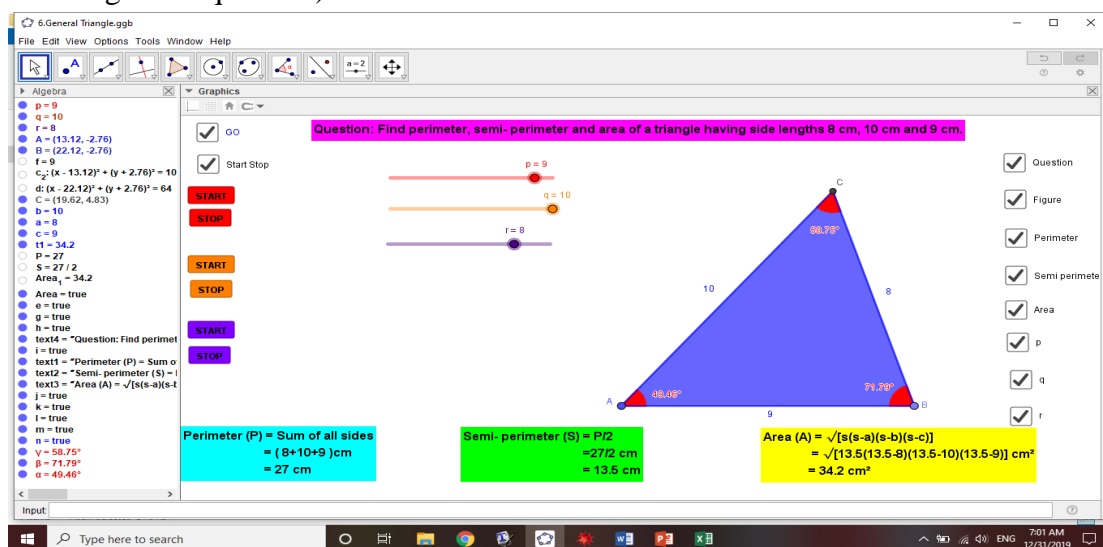
Activity- I

- Teacher will introduce GeoGebra software to the students
- Teacher will ask the following questions to the students to check their pre-knowledge:
 - What types of triangles are there on the basis of sides?
 - What is an altitude of a triangle?
 - How we define equilateral, isosceles and scalene triangles?
 - What type of triangle is called a right angled triangle?

- Is it possible for an equilateral triangle to be a right angled triangle? How?
- By using GeoGebra software, researcher will show all types of triangles (Equilateral triangle, Isosceles triangle and Scalene triangle)
- There will be a short time group discussion based on their answers
- Finally, with the help of group leader, teacher will define all types of triangles.

Activity – II

- Teacher will encourage the students to tell the answer of the following questions:
 - What is perimeter of a triangle?
 - How we calculate perimeter of a triangle?
 - What do you mean by semi- perimeter of a triangle and how we calculate it?
 - What is your understanding about the area of a triangle?
 - Which formulae we can use to calculate the area of a triangle (equilateral, isosceles, scalene, right angled triangle etc.)?
- Teacher will present the formulae to calculate the perimeter and area of triangles
- Teacher will demonstrate the perimeter, semi perimeter and area of triangle (a general question)



- Teacher will encourage students to find the perimeter and area of a triangle having side length 15 cm, 10 cm and 7 cm.

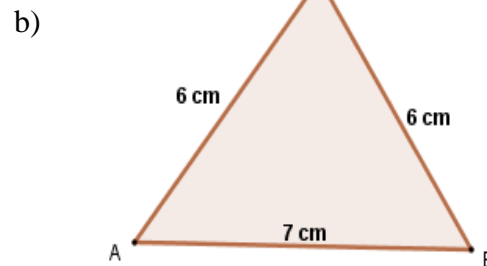
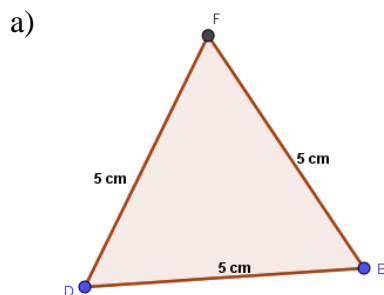
- Teacher will summarize the class.

4. Evaluation:

- Find the area of an isosceles triangle having the side length of equal sides 5 cm and remaining side is 8 cm.
- Find the area of right angled triangle having base length 24 cm and hypotenuse 25 cm long.

5. Homework:

Find the area of following triangles:



6. Appendix: Construction Protocol of general triangle on GeoGebra

1. Open GeoGebra classic 5.0
2. Click on navigation key and select 'Graphing'
3. Click on 'Graphics' and hide axes and grids
4. Click on slide tool and make a slider 'p' (min. 1, max. 10 and increment 1)
5. Similarly, make two more sliders 'q' and 'r' (values 1, 10, 1)
6. Click on line tool and select 'Segment with given length'
7. Click on screen write length 'p' then ok
8. Click on circle tool and select 'center and radius'
9. Click on A and write radius 'q' then ok
10. Click on B and write radius 'r' then ok
11. Click on point tool and select 'Intersect'

12. Click on any one intersecting point of both circles
13. Click on polygon tool and select 'Polygon'
14. Draw a triangle using the vertices A, B and C
15. Right click on a circle and select 'Show object'
16. Similarly, right click on another circle and select 'Show object'
17. Click on slider tool and select 'Text' and write the following

Question: Find perimeter, semi- perimeter and area of a triangle having side lengths a cm, b cm and c cm. [a, b and c must select from object]
18. Click on slider tool and select 'Text'
19. Click on screen and write the following:
 - Perimeter (P) = Sum of all sides
 - $= a + b + c$ [Select a, b and c from object]
 - $= \text{Perimeter}$ [To select perimeter from object, Write 'Perimeter = a + b + c' in input bar then enter]
 - Click on 'Ok'
20. Click on that text 'Perimeter.....' and use the tools given below graphics to decorate it
21. Follow the steps 18, 19 and 20 for Semi- perimeter and area using the respective formula
22. Click on slider tool and select 'Check box'
23. Click on screen and write 'Area' in caption
24. Select 'Text3' from select object.... Then click on apply
25. Follow the steps 22, 23 and 24 for perimeter, semi- perimeter and question
26. Again, click on slider tool and select 'Check box'
27. Click on screen and write 'Figure' in caption

28. Select 'Point A, Point B, Point C, Segment a, segment b, segment c and triangle t1' from object then click on 'Apply'
29. Right click on 'Area' button and select 'Fix check box'
30. Similarly, follow step 29 for other buttons
31. Manage the screen
32. 'Lock' and 'pin' all the text and 'fix check box'
33. Click on angle tool and select 'Angle'
34. Click on figure, hide name and manage the angle color
35. For automatic animation, do the following for all sliders:
 - i. Click on slider tool and select 'Ok' button
 - ii. Click on screen and write 'START' in caption
 - iii. Write 'StartAnimation[p]' in GeoGebra script then Ok
 - iv. Also, after (i), click on screen and write 'STOP' in caption
 - v. Write 'StartAnimation[p,false]' then Ok
 - vi. Similarly, follow the steps from (i) to (v) for other two sliders also.

Next, Use check box for six buttons (i.e. start stop) naming as 'Start Stop' and use it again for all buttons naming as 'GO' In this way all the above activities are taken under 'GO'.

Teaching Episode: 02

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Area of Triangle

1. Specific Objectives:

At the end of this class, students will be able to

- a) Find the area of triangle when base and altitude is given
- b) Find the perimeter, semi perimeter and volume of quadrilaterals

2. Teaching Learning Materials:

GeoGebra applet on “Area of Triangle”

3. Teaching Learning Activities:

Following activities will be done during the class period:

- Teacher will revise the previous class
- Teacher will ask the following questions to the students to check their pre-knowledge:

- Is it possible to find the area of triangle when base and altitude are given?
- How we calculate?
- Tell the process.
- How we calculate the area of a quadrilateral?

Activity - I

- Teacher will describe about the process of calculating area of triangle when base and altitude are given
- Teacher will present the following question (general question)

Triangle (base & altitude).ggb

File Edit View Options Tools Window Help

Algebra CAS Graphics

Question: Find the perimeter, semi-perimeter and area of a triangle having base length 3.88 cm and altitude 3.81 cm.

Perimeter (P) = Sum of all sides
 $= a+b+c$
 $= 4.4+7.17+3.88$
 $= 15.46$

Semiperimeter (S) = Perimeter/2
 $= 15.46/2$
 $= 7.73$

Area (A) = $1/2(\text{base} \times \text{height})$
 $= 1/2(c \times h)$
 $= 1/2(3.88 \times 3.81)$
 $= 7.4$

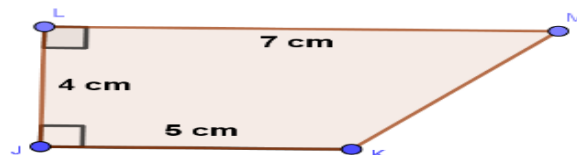
Input:

- There will be discussion between students and teacher about the above question

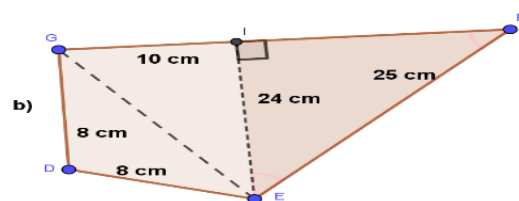
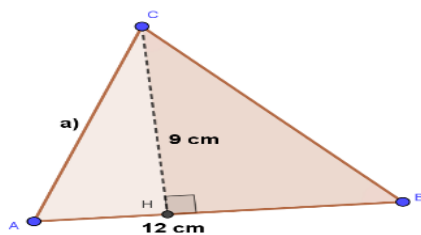
Activity - II

- Again, teacher will describe the process of finding perimeter and area of quadrilateral
- Teacher will solve the following question:

Question: Find the perimeter and area of the given figure.



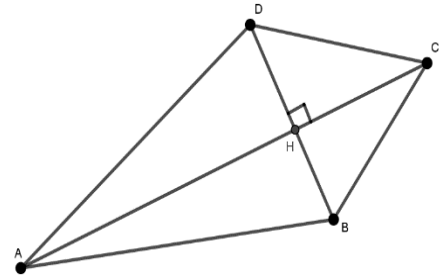
- On the process of demonstration, teacher will ask related questions to the students
- Teacher will encourage the students to find the area of following figures:



- If any student will unable to find the solution, students having more concept will help him/her
- Teacher will summarize the lesson

4. Evaluation

Find the area of the given figure alongside in which $AC = 10$ cm and $BD = 8$ cm. Also AH and CH are in the ratio of $3:2$ where $BH = DH$.



5. Homework

Solve exercise 5.1

6. Appendix: Construction protocol of triangle on GeoGebra (when base and altitude of a triangle are given)

1. Open GeoGebra classic 5.0
2. Click on navigation key and select 'graphing'
3. Use two options given below the Graphics and hide axes and grids
4. Click on polygon tool and select 'Polygon'
5. Click on screen three times and make a triangle
6. Click on line tool and select 'Line'
7. Click on A and B
8. Click on perpendicular line tool and select 'Perpendicular line'
9. Click on newly constructed line and fix the new line at C
10. Click on point tool and select 'Intersect'
11. Click on both the lines for their intersecting point
12. Click on polygon tool and select 'Polygon'
13. Click on B, D, C and B to make a triangle
14. Click on f and g in algebra view to hide lines f and g

15. Also hide the name of triangle BDC using graphics
16. Make BD and CD as dotted lines using graphics
17. Click on angle tool and select 'Angle'
18. Click inside of triangle BDC
19. Hide all angle name and values of triangle BDC
20. Choose white color for angle's symbol of triangle BDC except that of angle D
21. Click on slider tool and select 'Text'
22. Click on screen and write "Question: Find the perimeter, semi- perimeter and area of a triangle having base length c cm and altitude h cm." [c & h must select from objects]
23. Similarly, make text for perimeter, semi- perimeter and area using their own formulae.
24. Click on slider tool and select 'Check box'
25. Click on screen and write 'Question' in caption and select 'Text1' from select objects... then apply
26. Similarly, follow steps 24 and 25 for perimeter, semi perimeter, area and figure using their own information
27. Make a more check button namely GO for above buttons following the steps 24 and 25
28. Now decorate and manage the screen.

Teaching Episode: 03

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Area and Volume of a Cylinder

1. Specific Objectives:

At the end of this class, students will be able to

- a) Find the volume of cylinder
- b) Solve the questions related to volume of cylinder

2. Teaching Learning Materials:

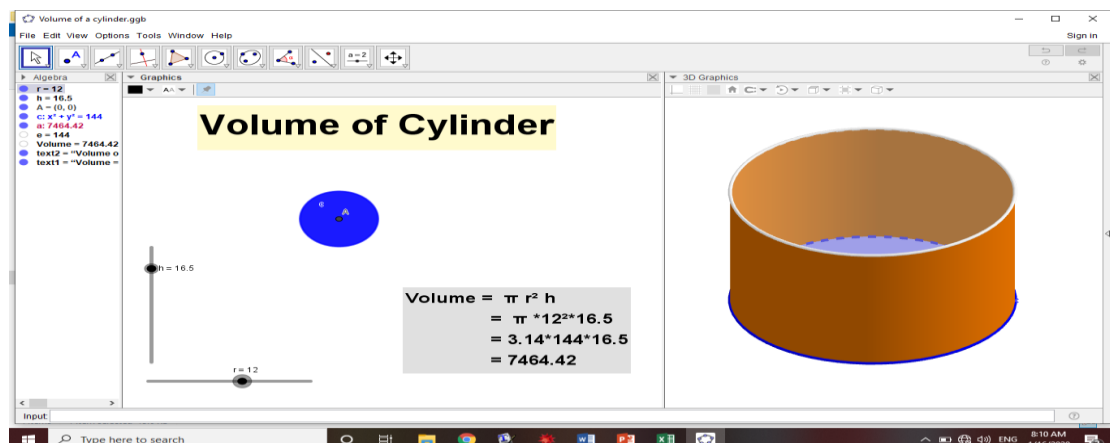
GeoGebra applet on “Area and Volume of Cylinder”

3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

Activity- I

- Revision of previous class
- Teacher will ask the questions to the students to check their pre- knowledge
- Teacher will explain about the volume
- Teacher will presents formula to calculate volume of cylinder
- Teacher will solve a question (general question) using GeoGebra software



- There will be discussion between students and teacher

- Students will conclude about the volume of cylinder

Activity- II

- Teacher will solve the following question (a general question) using GeoGebra
- The adjoining cylindrical vessel is 70 cm high and radius of its base is 35 cm. If it contains some water up to the height of 20 cm, then how much water (in liter) is required to fill the vessel completely?

Question: A cylindrical vessel is 70 cm high and its radius of base is 35 cm. If it contains some water up to the height of 20 cm, then how much water (in liter) is required to fill the vessel completely?

Volume of cylinder = 269391.57 cm³

Volume of water = 76969.02 cm³

Volume of empty space of cylinder (v) = $\pi r^2 H - \pi r^2 h$
= 192500 cm³

Volume of water (in litre) = 192500/1000 l
= 192.5 l

- Teacher will encourage the students to ask related questions.

4. Evaluation

Calculate volume of a cylinder having diameter of base 14 cm and height 15 cm

5. Homework

Solve questions 3 and 4 from exercise 6.1

6. Appendix

Construction Protocol of Cylinder (For activity II)

1. Open GeoGebra classic 5.0
2. Click on navigation key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'slider tool' and make a slider 'r' (0,50,0.5)

5. Similarly, make other two sliders naming as 'H' and 'h' for height of cylinder and level of water respectively
6. Click on circle tool and select 'center and radius'
7. Click on screen at (0,0) and write radius 'r' then 'ok'
8. Click on 3D Graphics then Click on pyramid tool and select 'extrude to prism'
9. Click on circle (at 3D view) and write altitude 'H' then 'ok'
10. Again, repeat steps 8 and 9 using 'h' instead of 'H'
11. Using 3D graphics, manage the different colors of both cylinders
12. Click on slider tool and select 'text'
13. Click on screen then write the following
 - Volume of water = $\pi r^2 h$
 - = $3.14 * r^2 * h$ [Insert r and h from object...]
 - = $3.14 * e * h$ [Insert e and h from object..., where we get e using r^2 in input bar]
 - = volume [Insert from object...., use volume = $\pi r^2 h$ then enter in input bar]
 - Finally, click on 'Ok'
14. Repeat steps 12 and 13 for volume of cylinder using the formula $\pi r^2 H$
15. Similarly, repeat steps 12 and 13 for volume of empty space of cylinder using the formula $(v) \pi r^2 H - \pi r^2 h$ and to calculate volume of water in liter use $v/1000 l$
16. Also, click on slider tool and select text then write 'Question: A cylindrical vessel is H cm high and its radius of base is r cm. If it contains some water up

to the height of h cm, then how much water (in liter) is required to fill the vessel completely? [H , h and r must be selected from object...]

17. Manage the font size, color of text and background of the text using 2D graphics
18. Click on slider tool and select 'Check box' then click on screen
19. Write 'Question' in 'Caption' and select text 5 from object... then click on 'Apply'
20. Similarly, follow the steps 18 and 19 for 'volume of cylinder', 'volume of water', 'volume of empty space' and 'volume of required water'
21. Finally, manage the all thing on the screen.
22. Make one more button namely 'GO' using slider tool and selecting 'Check box' to hide all thing from screen

Teaching Episode: 04

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Area and Volume of Sphere

1. Specific Objectives:

At the end of this class, students will be able to

- a) Find the surface area and volume of sphere
- b) Find the CSA, TSA and volume of hemisphere

2. Teaching Learning Materials:

- a) Offline sources: GeoGebra applet on “Area and Volume of Sphere”
- b) Online source: material-tNTNPDWe.ggb

3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

Activity- I

- Teacher will talk on previous class
- Teacher will ask question to the students to make the list of things which are similar to volley ball that we use to our daily life or available in our locality
- There will be small discussion between students and teacher about these listed things on the basis of shape, size, surface etc.
- Students will be asked the questions related with radius, diameter, surface area and Volume of sphere
- Teacher will show the sphere with the help of GeoGebra software and will tell the respective formulae
- Teacher will encourage the students to solve the question: Find the surface area and volume of sphere having radius 14 cm.

- If any student will unable to solve this problem, teacher will appoint other students of the class for helping them
- Finally, teacher will demonstrate the above questions with the help of GeoGebra

Question: Find the area and volume of a sphere having radius 16.5 cm.

Area of sphere = $4\pi r^2$
 $= 4 \times 22/7 \times 272.25 \text{ cm}^2$
 $= 3421.19 \text{ cm}^2$

Volume of Sphere = $\frac{4}{3}\pi r^3$
 $= \frac{4}{3} \times 3.14 \times 4492.13 \text{ cm}^3$
 $= 18816.57 \text{ cm}^3$

$r = 16.5$

Volume Area Question

Activity - II

- Teacher will ask the question following questions to the students:
 - Have you heard the word ‘hemisphere’?
 - What do you know about hemisphere?
 - Can you tell me parts of hemisphere?
 - Is there any relationship between sphere and hemisphere?
 - What will be the relationship between sphere and hemisphere on the basis of radius, diameter, surface area and volume?
 - What will be the formulae to calculate CSA, TSA and volume of hemisphere?
- Being based on these questions, there will be a short discussion among students
- Teacher will ask the conclusion of group discussion
- Teacher will solve a question of hemisphere using GeoGebra software

Hemisphere my.ggb

File Edit View Options Tools Window Help

Graphics

3D Graphics

Question: Find CSA, TSA and volume of a hemisphere having radius 61.5 cm.

Question

GSA

CSA

Volume

TSA

$r = 61.5$

$GCA = \pi r^2$
 $= 3.14 * 61.5^2 \text{ cm}^2$
 $= 11876.27 \text{ cm}^2$

$CSA = 2 \pi r^2$
 $= 2 * 3.14 * 61.5^2 \text{ cm}^2$
 $= 23752.53 \text{ cm}^2$

$TSA = 3 \pi r^2$
 $= 3 * 3.14 * 61.5^2 \text{ cm}^2$
 $= 35628.8 \text{ cm}^2$

$\text{Volume} = \frac{4}{3} \pi r^3$
 $= \frac{4}{3} * 3.14 * 61.5^3 \text{ cm}^3$
 $= 973853.73 \text{ cm}^3$

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- Teacher will give a question “If the circumference of great circle is 44 cm. Then find CSA, TSA and volume of hemisphere”
- Teacher will summarize the lesson

4. Evaluation:

Find the TSA and Volume of a spherical object having diameter 7 cm.

5. Homework:

Solve all the questions under the question number 5, 6 and 7 of exercise 6.1 of your text book.

6. Appendix: Construction Protocol of Sphere

1. Open GeoGebra classic 5.0
2. Click on navigation key and select ‘Graphing’
3. Click on ‘View’ and select ‘3D Graphics’
4. Click on ‘slider tool’ and make a slider ‘r’
5. Click on ‘circle tool’ and select ‘center and radius’
6. Click on screen at (0,0) and write radius ‘r’
7. Click on ‘sphere tool’ and select ‘center and radius’
8. Click on (0,0,0) and write radius ‘r’

9. Now, we have a sphere
10. Click on 'slider tool' and select 'text'
11. Write the following in 'edit'
 - Area of sphere = $4\pi r^2$
 - = $4*3.14*b$ [for 'b' put $r*r$ in input bar]
 - =Area [for 'Area' put $Area=4\pi r^2$ in input bar and then
select from objects]
 - Click on 'Ok'
12. Decorate the text
13. Follow the steps 10, 11 and 12 for volume [use the formula $\frac{4}{3}\pi r^3$]
14. Click on 'slider tool' and select 'check box'
15. Click on screen
16. Write 'Area' in caption
17. Select object 'text1' then apply
18. Write click on area button and select 'fix check box'
19. Follow the steps from 14 to 18 for volume.
20. Click on 'slider tool' and select 'button'
21. Click on screen and write 'START' in caption and 'StartAnimation[r]' in
script then 'ok'
22. Repeat the steps 20 and 21 and write 'STOP' and 'StartAnimation[r,false]'
then 'ok'
23. Write click on 'START' button and select 'fix object'
24. Follow the step 23 for 'STOP'
25. Now work is complete

Teaching Episode: 05

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Surface Area and Volume of Triangular Prism

1. Specific Objectives:

At the end of this class, students will be able to

- a) Identify the different parts of triangular prism
- b) Find the surface area and volume of triangular prism

2. Teaching Learning Materials:

GeoGebra applet on “Surface Area and Volume of Triangular Prism”

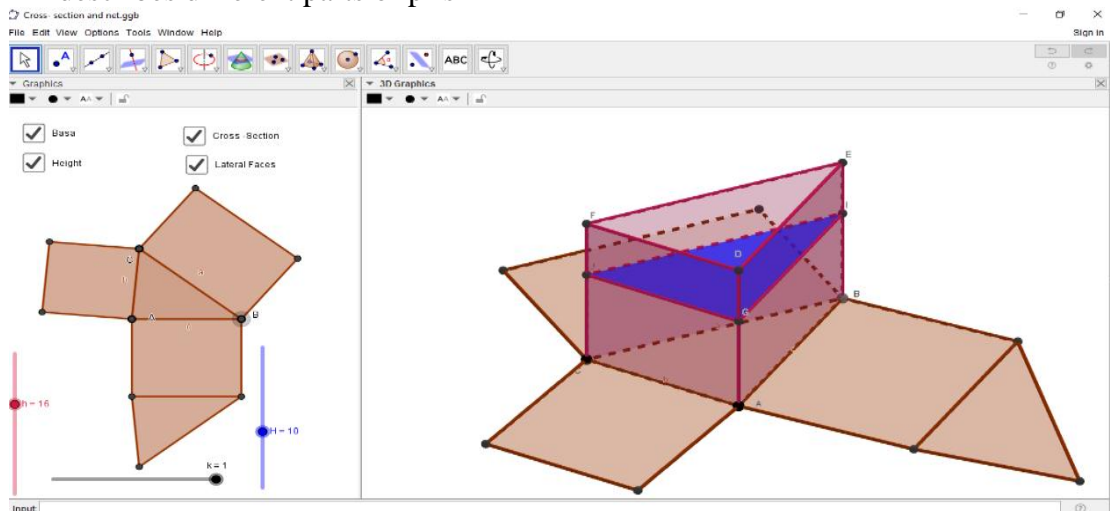
3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

Activity I

- Teacher will revise previous class
- Teacher will ask the following questions to the students:
 - What is a prism?
 - How do you define a triangular prism?
 - Do you know about cross- section of a prism?
 - Is there any relation between area of cross- section and base area of a triangular prism?
 - Tell me the name of different parts of triangular prism.
 - How we calculate base area, lateral surface area, total surface area and volume of triangular prism?
- Teacher will note the students answer in white board and then there will be short discussion about these points

- Teacher will presents the triangular prism with its net as given below and describes different parts of prism



Activity II

- After describing different parts of triangular prism, teacher will tell the formulae which we need to calculate base area, cross- sectional area, lateral surface area, total surface area and volume of triangular prism
- Teacher will describe the process to calculate area and volume of triangular prism
- Then, teacher will solve the question using GeoGebra software: Find the base area, LSA, TSA and volume of a triangular prism with length 19.05 cm and length of sides of base are 13.5 cm, 14.5 cm and 17.5 cm. (A general question)

Find base area, LSA, TSA and volume of a triangular prism with length 19.05 cm and length of sides of base are 13.5 cm, 14.5 cm and 17.5 cm.

Base Area = $\sqrt{[S(S-a)(S-b)(S-c)]}$
 $= \sqrt{[22.75(22.75-13.5)(22.75-14.5)(22.75-17.5)]}$ cm²
 $= 95.47$ cm²

LSA = PI
 $= 45.5 * 19.05$ cm²
 $= 866.91$ cm²

TSA = $2A + PI$
 $= (2*95.47 + 45.5*19.05)$ cm²
 $= 1057.85$ cm²

Volume = Base Area * Height
 $= 95.47*19.05$ cm³
 $= 1818.98$ cm³

- On the process of demonstration, teacher will encourage students to ask related questions about the solution
- Finally, teacher will summarize the lesson

4. Evaluation:

- Why we use $LSA = Pl$? Explain it.
- Find base area, LSA, TSA and volume of an equilateral triangular based prism with length 20 cm and side length 8 cm.

5. Homework

Solve exercise 7.1

6. Appendix

Construction protocol of triangular prism

1. Open GeoGebra 5.0
2. Click on navigation key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'Graphics' in 2D view then hide axes and grids
5. Click on '3D Graphics' then hide axes and plan
6. Click on 'Slider' tool and make a slider 'a' (1, 20, 0.5)
7. Similarly, make three more sliders namely 'b', 'c' and 'h'
8. First click on 'Line' tool then click on screen and write length 'a' then 'Ok'
9. Click on 'Circle' tool and select 'Circle: center and radius'
10. Click on 2D screen at point B and write radius 'b' then 'Ok'
11. Similarly, click at point A and write radius 'c' then 'Ok'
12. Click on 'Point' tool and select 'Intersect'
13. Click at any one of intersecting place of both circles
14. Right click on a circle and select 'Show object'

15. Similarly, hide another circle
16. Click on 'Polygon' tool and select 'Polygon'
17. Click on A, B, C and A
18. Now triangle ABC is ready
19. Click on 'Pyramid' tool and select 'Extrude to prism'
20. Click on any side of triangle at 3D view and write altitude 'h' then 'Ok'
21. Now triangular based prism is ready
22. Click on 'Slider' tool and select 'Text'
23. Click on screen and write the text "Find base area, LSA, TSA and volume of a triangular prism with length h cm and length sides of base are a cm, b cm and c cm" then .Ok. Here h, a, b and c must be insert from object....
24. For perimeter of base of prism, write $P = a + b + c$ in input bar then press "Enter" key
25. For semi- perimeter of base of prism, write $S = (a + b + c)/2$ in input bar then press 'Enter' key
26. Again, select 'Text' after a click on 'Slider' tool
27. Click on screen and write the following text
 - i. "Base Area = $\sqrt{S(S - a)(S - b)(S - c)}$ [Formula]

$$= \sqrt{S(S - a)(S - b)(S - c)} \text{ cm}^2$$
 here S, a, b and c must insert from 'object...'
 = Insert A_1 from 'object...' [Use $A_1 = (S*(S-a)*(S-b)*(S-c))^{0.5}$ in input bar then press 'Enter' key]"
 - ii. Follow steps 26 then do the similar work as in step 27 (i) for LSA, TSA and volume of prism

28. Click on 'Slider' tool and select 'Check box'
29. Click on screen and write 'Question' in caption and select 'Text1' from 'Select objects....' then click on 'Apply'
30. Follow steps 28 and 29 for base area, LSA, TSA and volume of prism selecting their corresponding texts
31. Finally, make one more 'Check box' namely 'GO' and decorate the texts and screen.

Note: - To show the net of above prism, we need to click on 'Pyramid' tool then select 'Net'. After this, click on any side of triangle at base of 3D view.

Teaching Episode: 06

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Pyramid

1. Specific Objectives:

At the end of this class, students will be able to

- a) Define a square based pyramid
- b) Identify different parts of a square based pyramid
- c) To calculate surface area and volume of a square based pyramid

2. Teaching Learning Materials:

GeoGebra applet on “Pyramid”

3. Teaching Learning Activities:

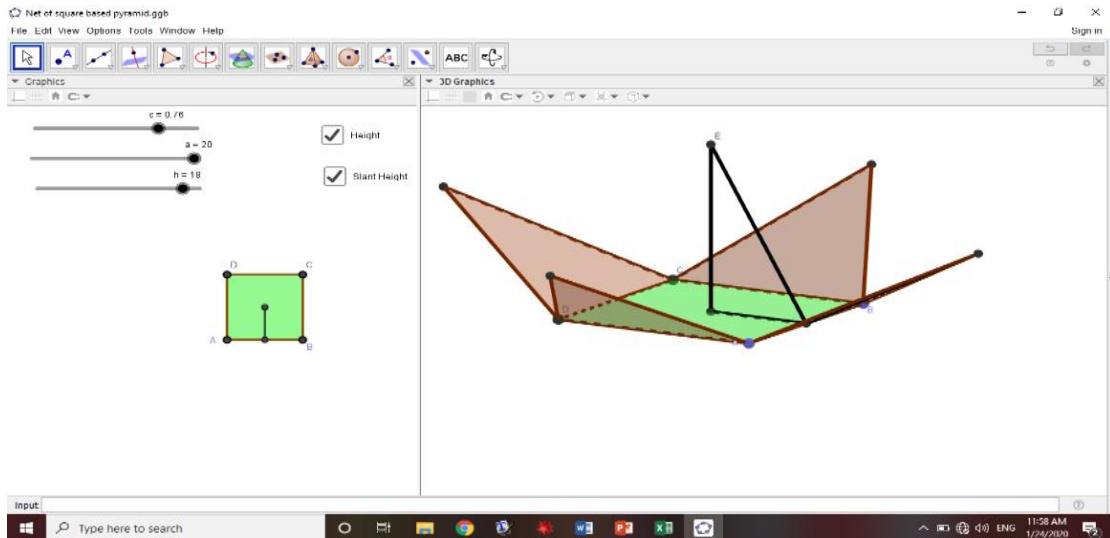
Teacher will do the following activities during the class period:

- Teacher will revise previous class
- Teacher will ask the following questions to the students:
 - What is a pyramid?
 - Do you know about lateral faces of a square based pyramid?
 - How many faces are there in a square based pyramid?
 - What is the relationship among lateral faces of a square based pyramid?
 - What are the formulae to calculate base area, lateral surface area, total surface area and volume of a square based pyramid?
- First, teacher will define a pyramid and then square based pyramid as follow:

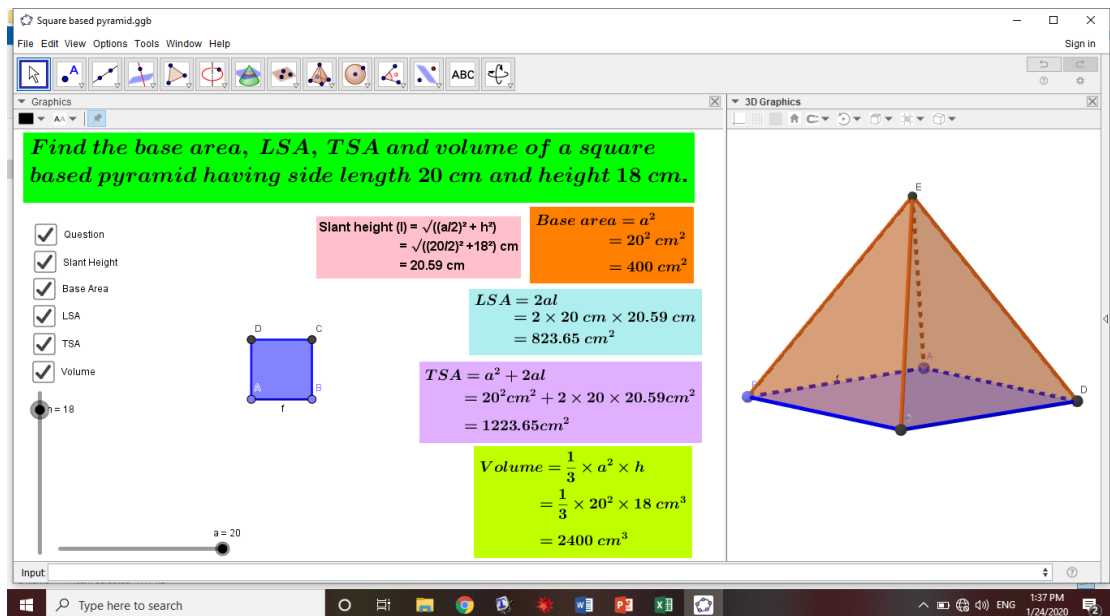
Pyramid: A pyramid is a solid having a polygonal base and triangular faces. The triangular faces meet at a common point called vertex.

Square based pyramid: A pyramid is a square based pyramid if its base is a square.

- Teacher will describe about the different parts (base, faces. Vertex, vertical height, slant height, etc.) of square based pyramid by demonstrating the net of square based pyramid as follow:



- On the time of demonstration, teacher will ask related questions to the students
- Teacher will find base area, lateral surface area, total surface area and volume of a square based pyramid using GeoGebra software as follow:



volume of a square based pyramid

- Teacher will give a question :- “Find TSA and volume of a square based pyramid having side length 8 cm, height 3 cm and slant height 5 cm” to the students

- If any student will not be able for solution, then student having good concept will help him/ her
- Teacher will summarize the lesson.

4. Evaluation:

- a) Define a square based pyramid.
- b) Tell the name of different parts of a square based pyramid.
- c) How we calculate the volume of a square based pyramid when height and slant height are given?
- d) Calculate LSA and volume of a square based pyramid having base length 16 cm and height 6cm.

5. Homework:

Solve question no. 1(a), (c) and 2(a), (b) of exercise 7.2.

6. Appendix: Construction protocol (net) of square based pyramid

1. Open GeoGebra 5.0
2. Click on 'Navigation' key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'Slider' tool and select 'Slider'
5. Click on screen and make a slider 'a' (1, 20, 0.5) then 'Ok'
6. Similarly, make another slider 'h'
7. Click on 'Line' tool and select 'Segment with given length'
8. Click on screen and write length 'a' then 'Ok'
9. Click on 'Polygon' tool and select 'Regular polygon'
10. Click on the points A and B on 2D screen and write '4' then 'Ok'
11. Click on 'Pyramid' tool and select 'Extrude to pyramid'
12. Click on any side of square on 3D view and write altitude 'h' then 'Ok'

13. Again, click on 'Pyramid' tool and select 'Net'
14. Click on any side of base of pyramid on 3D view
15. Now, using 'Algebra' view, hide the pyramid
16. Click on 'line' tool and select 'segment'
17. Join A & C and B & D
18. Click on 'Point' view and select 'Intersect'
19. Click on AC and BD
20. Click on 'Line' tool and select 'Segment'
21. Join E and N
22. Click on 'Point' tool and select 'Midpoint or center'
23. Click on the points A and B
24. Click on 'Line tool' and select 'Segment'
25. Join 'O' and the point on top of that triangular face
26. Click on 'Line' tool and select 'Segment'
27. Join the points O and N
28. Similarly, join the points O and N
29. Click on 'Slider' tool and select 'Text'
30. Click on screen and write 'Height' in caption and select 'segment m' from
select... then 'Apply'
31. Similarly make check box for slant height etc.
32. Finally, decorate and manage the screen.

Teaching Episode: 07

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Pyramid

1. Specific Objectives:

At the end of this class, students will be able to

- a) Define a rectangular pyramid
- b) Identify different parts of a rectangular pyramid
- c) To calculate surface area and volume of a rectangular pyramid

2. Teaching Learning Materials:

GeoGebra applet on “Pyramid”

3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

- Teacher will revise previous class
- Teacher will ask the following questions to the students:
 - What is your understanding about rectangular pyramid?
 - Tell the name of different parts of rectangular pyramid.
 - What are the formulae to calculate surface area and volume of rectangular pyramid?
 - What is the relationship between the opposite faces of a rectangular pyramid?
- After the discussion on above questions, teacher will define a rectangular pyramid as “A pyramid is called a rectangular pyramid if its base is rectangle”
- Also, using net of pyramid, teacher will discuss about different parts of rectangular pyramid

- Teacher will present the formulae to calculate base area, lateral surface area, total surface area and volume of rectangular pyramid
- Teacher will solve the following question of rectangular pyramid using GeoGebra software:

Reactangular Pyramid.ggb a.ggb
File Edit View Options Tools Window Help

Graphics

Find base area, LSA, TSA and volume of a rectangular pyramid with height 6 cm and length of sides on base are 5 cm and 5 cm.

Question L1 L2 Base Area LSA TSA Volume

Slant height along length = 6.5 cm
Slant height along breadth = 6.5 cm
Base area = 25 cm²

$LSA = a \times l_1 + b \times l_2$
 $= 32.5 \text{ cm}^2 + 32.5 \text{ cm}^2$
 $= 65 \text{ cm}^2$

$TSA = 25 \text{ cm}^2 + 65 \text{ cm}^2$
 $= 90 \text{ cm}^2$

Volume = 50 cm³

a = 5 b = 5 h = 6

3D Graphics

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- Teacher will ask the related questions to the students on the process of solving above problem
- Teacher will summarize the lesson

4. Evaluation

- Define rectangular based pyramid.
- Tell the name of different parts of rectangular pyramid.
- How we calculate LSA of a rectangular pyramid when length of base and height is given? Tell the process of calculation.
- Find TSA and volume of rectangular based pyramid with a = 6 cm, b = 8 cm and h = 4 cm.

5. Homework:

Solve all the questions of general section of exercise 7.2 related with rectangular pyramid.

6. Appendix: Construction Protocol of rectangular pyramid

1. Open GeoGebra 5.0
2. Click on 'Navigation' key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'Slider' tool and select 'Slider'
5. Click on screen and make a slider 'a' (1, 20,1) then 'Ok'
6. Similarly, make two more sliders namely 'b' and 'h'
7. Click on 'Line' tool and select 'Segment with given length'
8. Click on screen and write length 'a' then 'Ok'
9. Click on 'Circle' tool and select 'Circle: center and radius'
10. Click on point A and write radius 'b' then 'Ok'
11. Click on 'Perpendicular Line' tool and select 'Perpendicular line'
12. Click on line AB then click on the point A
13. Click on 'Point' tool and select 'Intersect'
14. Click on circle and perpendicular line to get intersecting point
15. Again, follow the similar steps from 9 to 14 at the point B
16. Click on 'Polygon' tool and select 'polygon'
17. Join the points A, B, F, D and A
18. Right click on a circle and select 'Show object'
19. Also, hide another circle and perpendicular lines
20. Click on 'Pyramid' tool and select 'Extrude to Prism'
21. Click on quadrilateral on 3D view and write altitude 'h'
22. Click on 'Point' tool and select 'Midpoint or center'
23. Click on the points A and B
24. Also, construct the midpoint of side AD

25. Click on 'Line' tool and select 'Segment'
26. Join the points H and G
27. Also, join the points L and G
28. Similarly, construct diagonals of quadrilateral ABFD
29. Click on 'Point' tool and select 'Intersect'
30. Click on both diagonals to get intersecting point
31. Click on 'Line' tool and select 'Segment'
32. Join the points J and G
33. Click on 'Slider' tool and select 'Text'
34. Click on screen and write the text: Find base area, LSA, TSA and volume of
a rectangular pyramid with height h cm and length of sides on base are a cm
and b cm. [h, a and b insert from object...]
35. Similarly, write the text for slant heights, base area, LSA, TSA and volume
36. Click on 'slider' tool and select 'Check box'
37. Click on screen and write 'Question' in caption and select 'text1' from
'Select object...' then 'Apply'
38. Similarly, make check box
39. Finally, manage and decorate the screen.

Teaching Episode: 08

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Pyramid

1. Specific Objectives:

At the end of this class, students will be able to

- a) To calculate surface area and volume of a combined object

2. Teaching Learning Materials:

GeoGebra applet on “Pyramid”

3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

- Teacher will revise previous class
- Teacher will ask the following questions to the students:
 - What is a cube?
 - How do you define a cuboid?
 - How we calculate surface area and volume of cube, cuboid, triangular prism?
- Based on students’ responses, there will be a short time discussion
- Teacher will tell the process of calculation of surface area and volume of combined object with formulae [combination of prism and pyramid]
- Teacher will demonstrate the solution of a question for combined object

Construction of combined object.ggb

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Sign in

Graphics 3D Graphics

Find base area, LSA, TSA and volume of a combined object made by cuboid and pyramid where side length of cuboid are $AB = 3\text{ cm}$, $AD = 4\text{ cm}$, $AG = 3\text{ cm}$ and height of pyramid is 5 cm

Question
 L1
 L2
 A1
 A2
 TSA
 Volume

Slant height along GI (L_1) = 5.22 cm
 Slant height along GK (L_2) = 5.39 cm
 Base Area (A_1) = 12 cm^2
 LSA (A_2) = 79.2 cm^2
 TSA = $12\text{ cm}^2 + 79.2\text{ cm}^2 = 91.2\text{ cm}^2$
 Volume = 56 cm^3

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- On the process of demonstration, there will be students teacher discussion
- If any student will unable to understand the solution then teacher will appoint students having good concept on related topic to develop their concept
- If needed, teacher will describe
- Teacher will summarize the lesson

4. Evaluation:

<p>a) Lower most part is cube with $FG = 6\text{ cm}$ and height of pyramid</p>	<p>b) Lower most part is cuboid with $FG = 8\text{ cm}$, $GM = 5\text{ cm}$ and height of</p>
--	---

Find TSA and volume of the following combined objects:

5. Homework:

Solve question number 5 of exercise 7.2

6. Appendix: Construction protocol of combined object made by cuboid and pyramid

1. Open GeoGebra 5.0
2. Click on 'Navigation' key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'Slider' tool and select 'Slider'
5. Click on screen and make a slider 'a' (1, 20,1) then 'Ok'
6. Similarly, make three more sliders namely 'b', 'h' and 'H'
7. Click on 'Line' tool and select 'Segment with given length'
8. Click on screen and write length 'a' then 'Ok'
9. Click on 'Circle' tool and select 'Circle: center and radius'
10. Click on point A and write radius 'b' then 'Ok'
11. Click on 'Perpendicular Line' tool and select 'Perpendicular line'
12. Click on line AB then click on the point A
13. Click on 'Point' tool and select 'Intersect'
14. Click on circle and perpendicular line to get intersecting point
15. Again, follow the similar steps from 9 to 14 at the point B
16. Click on 'Polygon' tool and select 'polygon'
17. Join the points A, B, F, D and A
18. Right click on a circle and select 'Show object'
19. Also, hide another circle and perpendicular lines
20. Click on 'Pyramid' tool and select 'Extrude to Prism'
21. Click on quadrilateral on 3D view and write altitude 'H'

22. Again, click on 'Pyramid' tool and select 'Extrude to Pyramid'
23. Click on upper face of cuboid and write altitude 'h'
24. Click on 'Slider' tool and select 'Text'
25. Click on screen and write the text: Find base area, LSA, TSA and volume of combined object made by cuboid and pyramid where side length of cuboid are $AB = a$ cm, $AD = b$ cm, $AG = H$ cm and height of pyramid is h cm then 'Ok' [a, b, h and H insert from 'Object...']
26. Similarly, write the text for slant height of pyramid, base area, LSA, TSA and volume
27. Click on 'Slider' tool and select 'Check box'
28. Click on screen and write 'Question' in 'caption' and select 'Text1' from 'Select object...'
29. Similarly, make check boxes for other text
30. Finally, decorate and manage the screen

Teaching Episode: 09

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Cone

1. Specific Objectives:

At the end of this class, students will be able to

- a) Identify different parts of cone
- b) To calculate surface area and volume of a cone

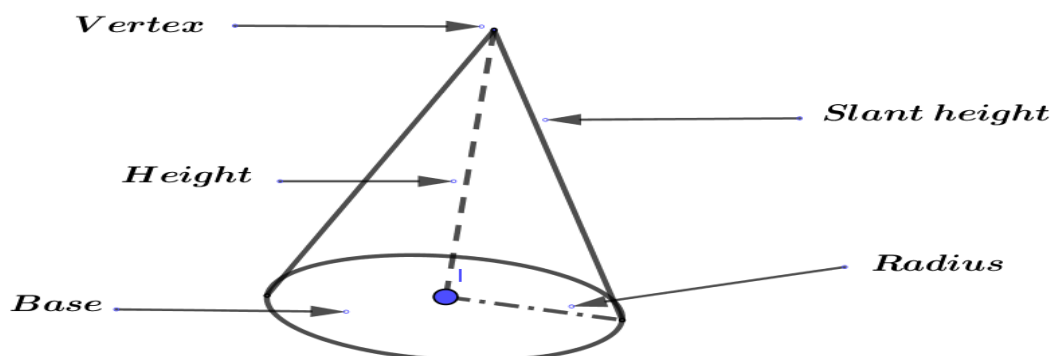
2. Teaching Learning Materials:

GeoGebra applet on “Cone”

3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

- Teacher will revise previous class
- Teacher will ask the following questions to the students:
 - What is your understanding about a cone?
 - What do you think about ‘cone is a pyramid’?
 - What are the parts of a cone?
 - Which formulae do we use to calculate surface area and volume of a cone?
- Based on students answer, there will be interaction between teacher and students
- Teacher will present the different parts of cone as follow:



- There will be interaction about figure and relation of different parts of cone
- Teacher will tell the formulae to calculate slant height, surface area and volume of cone as follow:

- Slant height = $\sqrt{r^2 + h^2}$
- Base area = πr^2
- Curved surface area = $\pi r l$
- Total surface area = $\pi r^2 + \pi r l$
- Volume = $\frac{1}{3} \pi r^2 h$, where r, h and l are radius of base, height and slant height of cone respectively

- Teacher will sole the following question of cone with using GeoGebra software

Find base area, CSA, TSA and volume of a cone with radius 12 cm and height 16 cm.

Radius = 12 cm
Height = 16 cm

Slant height (l) = $\sqrt{r^2 + h^2}$
= $\sqrt{12^2 + 16^2}$
= 20 cm

Base Area = πr^2
= $3.14 \times 12^2 \text{ cm}^2$
= 452.16 cm^2

CSA = $\pi r l$
= $3.14 \times 12 \text{ cm} \times 20 \text{ cm}$
= 753.6 cm^2

TSA = $\pi r^2 + \pi r l$
= $452.16 \text{ cm}^2 + 753.6 \text{ cm}^2$
= 1205.76 cm^2

Volume = $\frac{1}{3} \pi r^2 h$
= $\frac{1}{3} \times 3.14 \times 12^2 \times 16 \text{ cm}^3$
= 2411.52 cm^3

- On the process of solving question, there will question answer between teacher and students
- If any student will unable to understand the process of calculation for solution then teacher will request the student having good concept on the topic to describe the process
- If needed teacher will describe
- Teacher will summarize the lesson

4. Evaluation

- a) Find base area, CSA, TSA and volume of cone with radius 7 cm and height 10 cm.
- b) Find TSA and volume of a cone having radius 24 cm and slant height 25 cm.

5. Homework

Solve question number 4 of exercise 7.3

6. Appendix: Construction protocol of a cone

1. Open GeoGebra 5.0
2. Click on 'Navigation' key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'Slider' tool and select 'Slider'
5. Click on screen and make a slider 'r' (1, 20,1) then 'Ok'
6. Similarly, make one more slider namely 'h'
7. Click on 'Circle' tool and select 'Circle: center and radius'
8. Click on screen at (0, 0) and write radius 'r' then 'Ok'
9. Click on 'Pyramid' tool and select 'Extrude to Pyramid'
10. Click on circle on 3D view and write altitude 'h' then 'Ok'
11. Click on 'Point' tool and select 'Point'
12. Click on circle at any point
13. Click on 'Polygon' tool and select 'Polygon'
14. Click on the points A, B, C and A
15. Click on 'Angle' tool and select 'Angle'
16. Click on points C, A and B
17. Click on 'Slider' tool and select 'Text'

18. Click on screen and write the text: “Find base area, CSA, TSA and volume of a cone with radius r cm and height h cm” then click on ‘Ok’ [here r and h must be inserted from ‘Object....’]

19. Again, follow the step 17 and click on screen then write the text:

$$\text{Base Area} = \pi r^2$$

$$= 3.14 * r^2 \text{ [Insert r from 'Objects....']}$$

$$= A1 \text{ [Insert A1 from 'Objects...' write in input bar } A1=3.14*r^2$$

then press enter key]

20. Similarly, write other text

21. Finally manage the screen and decorate it.

Teaching Episode: 10

Subject: Mathematics

Time: 40 min.

Unit: Mensuration

Grade: 10

Topic: Cone and Cylinder

1. Specific Objectives:

At the end of this class, students will be able to

- a) To calculate surface area and volume of combined object (cone + cylinder)

2. Teaching Learning Materials:

GeoGebra applet on “Cone and Cylinder”

3. Teaching Learning Activities:

Teacher will do the following activities during the class period:

- Teacher will revise previous class
- Teacher will ask questions to the students to check their pre- knowledge
- There will be short time group discussion among students about surface area and volume of combined object made from cylinder and cone
- Teacher will ask the group leaders to present the conclusion in the class
- Teacher will describe the process to calculate the surface area and volume of combined object (cone + cylinder) and tell the following formulae by demonstrating the figure on GeoGebra

- Slant height of cone $(l) = \sqrt{r^2 + h^2}$
- CSA of cone $= \pi rl$
- CSA of cylinder $= 2\pi rH$
- Base area of cylinder $= \pi r^2$
- TSA of object $=$ Base area $+ \text{CSA of cylinder} + \text{CSA of cone}$

$$= \pi r^2 + 2\pi rH + \pi rl$$

- Volume of cone = $\frac{1}{3} \pi r^2 h$
- Volume of cylinder = $\pi r^2 H$
- Volume of object = volume of cone + volume of cylinder

$$= \frac{1}{3} \pi r^2 h + \pi r^2 H$$

- Teacher will solve following question of combined object with the help of GeoGebra software

Find base area, CSA, TSA, and volume of a combined object made by cylinder and a cone with common radius 12 cm, height of cylinder 18 cm and height of cone is 17 cm.

Radius of base = 12 cm
 Height of cylinder = 18 cm
 Height of cone = 17 cm

Slant Height = $\sqrt{r^2 + h^2}$
 = 20.81 cm

Base Area = πr^2
 = 452.16 cm²

CSA = $2\pi rH + \pi rl$
 = 2140.55 cm²

TSA = $\pi r^2 + 2\pi rH + \pi rl$
 = 2592.71 cm²

Volume = $\pi r^2 H + \frac{1}{3} \pi r^2 h$
 = 10701.12 cm³

Question
 Radius
 H. of cylinder
 H. of cone
 S. Height Base Area CSA TSA Volume More

- On the process of solving question, there will be interaction between teacher and students
- Finally, teacher will summarize the lesson

4. Evaluation

Find surface area and volume of a combined object made by cylinder and cone having radius 4 cm and slant height of conical part is 5 cm and total height of object is 20 cm.

5. Homework

Solve questions 6 (a), (b), (c) and 7 (a), (b), (c) of exercise 7.3

6. Appendix: Construction protocol of combined object (cylinder + cone)

1. Open GeoGebra 5.0
2. Click on 'Navigation' key and select 'Graphing'
3. Click on 'View' and select '3D Graphics'
4. Click on 'Slider' tool and select 'Slider'
5. Click on screen and make a slider 'r' (1, 20,1) then 'Ok'
6. Similarly, make two more sliders namely 'h' and 'H'
7. Click on 'Circle' tool and select 'Circle: center and radius'
8. Click on screen at (0, 0) and write radius 'r' then 'Ok'
9. Click on 'Pyramid' tool and select 'Extrude to Prism'
10. Click on circle on 3D view and write altitude 'H' then 'Ok'
11. Click on 'Pyramid' tool and select 'Extrude to Pyramid'
12. Click on upper circle (base) on 3D view and write altitude 'h' then 'Ok'
13. Click on 'Point' tool and select 'Point'
14. Click at any point on the circle (base of cylinder)
15. Click on 'Line' tool and select 'Segment'
16. Join center of cylinder with point on circle (on base)
17. Similarly, join vertex of cone with center of circle (on base of cylinder)
18. Click on 'Perpendicular Line' tool and select 'parallel line'
19. Click on line AD then click on point B (at circle on base of cylinder)
20. Click on 'Point' tool and select 'Intersect'
21. Click on parallel line through point B then click on upper circle (on base of cone), we get point C

22. Do the similar work as steps 18 to 21 and draw a parallel line with AB (radius of lower most circle) and intersecting point of that line and combined height
23. Right click on a line and select 'Show object'
24. Do the same work as in step 23 for another line
25. Click on 'Line' tool and select 'Segment'
26. Join the points B & C, C & E and C & D
27. Click on 'Slider' tool and select 'Text'
28. Click on screen and write the text: "Find base area, CSA, TSA and volume of a combined object made by cylinder and cone with common radius r cm, height of cylinder H cm and height of cone h cm" then click on 'Ok' [here r, h and H must be inserted from 'Object...']
29. Again, follow the step 27 and click on screen then write the text:

$$\begin{aligned}
 \text{S. Height} &= \sqrt{r^2 + h^2} \\
 &= \sqrt{r^2 + h^2} \text{ [Insert r and h from 'Objects...']} \\
 &= L \text{ [Insert L from 'Objects...' write in input bar } L = (r^2+h^2)^{0.5} \\
 &\text{ then press enter key]}
 \end{aligned}$$

30. Similarly, write other text
31. Click on 'Slider' tool and select 'Check box'
32. Click on screen and write 'Question' in 'caption' and select 'Text1' from 'Select object...' then 'Apply'
33. Similarly, make check boxes for other text also.
34. Finally manage the screen and decorate it.

Note: - To construct cylinder and cone: steps 1 to 12

To show radii, slant height of cone, height of cone: steps 13 to 26

To write text and make check box: steps 27 to 34