CHAPTER- I

INTRODUCTION

Background of the study

The term 'mathematics' has been interpreted and explained in various ways. According to Schaaf 'mathematics' is derived from the word 'mathanein' which means to incline to learn. According to Oxford dictionary (Sixth edition) "Mathematics is the science of number and space". A famous 19th century mathematician Albert Einstein defined, "Mathematics is a free investigation of the human intellect". According to Roger Bacon, Mathematics is the gate and key of Science. Neglect of mathematics works injury to all knowledge, since he who thinks of the world and what are worse men who are thus ignorance and so do not seek a remedy (Eves, 1983).

Mathematics education is defined as a science that deals mathematics from educational point of view. Mathematics point of views mathematics from different aspects.Philosophical, psychological and sociological. Mathematics education has also its own term and terminologies but doesn't have exam, postulates and theorems. Instead, it has its own theories and concern to problem of learning and teaching. Mathematics education is not obliged to create new mathematics or make new generalisation.

Formally, mathematics education as a discipline got recognition from International congress of mathematics education (ICME, 1969) held at Lyons. Mathematics education considered different environmental factors such as student background and his/her surroundings, influencesincluding scientific attitudes. Finally, mathematics education concern about curriculum framing, teaching and evaluation of

mathematics learning. Mathematics education divided into four major

areas (higher arithmetic, algebra, geometry and analysis) and geometry is one of the

major areas. Geometry is one of the most useful and important branch of mathematics

education.

Manipulative materials are concrete model that can involve mathematical

concepts, appealing to several senses including the socio-cultural need that can be

touched and moved around by the learners (Heddens, 2005). Manipulative are

physical objects such as tangram, algebra tiles, base-ten block, geo-board, Cuisenaire

rods, fraction pieces, pattern blocks and geometric solids that can make abstract ideas

and symbols more meaningful and understandable to students. Working with

manipulative improves performance on mathematical tasks. (Chao.Et. Al. 2000).

Manipulative have been shown to support learning in both arithmetic and geometric

context. (Glenbery, Jawarski, Ricchal and Levin, 2006, Jawarski, 2003, Olkun, 2003

Reimer and Moyer, 2005) England, Japan, China and USA supports that mathematics

instruction to student effective of manipulative materials are used. (Canny, 1984,

elements and Batista; Dienes 1960; Syudam 1984; Fennema 1972-1973). The use of

manipulative in classroom have long been recommended by educators (NTCM 1989)

and even mention in State Legislation of Texas Chapter -75, as new concept should be

introduced with appropriate manipulative at the elementary level (Peaveler et. Al.

1987) and in California, the use of manipulative device in all elementary classroom is

recommended (Gilbert and Bush 1988). In the elementary level students who use

manipulative for extended period of times performs better on achievement test than

those who don't (Sowell, 1989).

It is Suggested that manipulative materials can be used as an intermediary

between the real world and mathematical world (Lesh, 1979), Moreover, the use of

manipulative material as a concrete models be more abstract that the factual situation but less abstract than formal symbols. Using manipulative benefits students across grade level, ability level and topic which using manipulative make sense but for that topic (Driscell; 1983, sowell; 1989, suyclam; 1986) post (1981) and Denes (1961) emphasis using manipulative in order to provide a concrete referent for a concept, often at more than one level, instead of referent for a given obstract idea or procedure suydam and Hungins (1976) believe that lesson involving manipulative materials, if employed properly will produce grater mathematical achievement than will lesson in which manipulative not used. According to hidden (2006) manipulative materials help to students:

- To relate real word situation to mathematical symbolism.

- To work together co-operatively in solving problem.

- To discuss mathematical ideas and concepts.

- To verbalize their mathematical thinking.

- To make presentation in front of large group that is different way to solve the problem.

Teaching materials are often said to focus attention on meaning, help to make the mathematics taught in classroom move realistic and alive, challenge pupils attention, stimulate, imagination, facilitate the understanding of the pupils provide incentive for action, develop ability to listen and also develop various skills and even the teaching materials complement or supplement the teacher.

In geometry teaching, we use different instructional materials among them, tangram is one instructional material. It is suitable for teaching geometry at secondary level. Tangram is made by the cutting of square plywood carton or hard

paper into seven pieces different geometrical figure (triangles, square and parallelogram). From the combination and rearrangement of seven pieces of different geometrical figure, we can make different geometrical model or shape like triangle, parallelogram, rhombus, rectangle etc. and other different figure.

Tangram is a new and concrete material to teach geometry. It is useful material for secondary level student to give the concept of geometry. Tangram has wide range of application teaching geometry at secondary level. Geometric concept and theorem based on triangle, rectangles, squares, parallelogramand rhombus can be taught more clearly to the students by use of tangram. As the student can manipulate this materials so it is an effective means of teaching. Students can form a group and identity of the geometrical figure by the help of tangram. This is the way of learning by playing game. So it is an important material at secondary level. In the context of Nepal, the study of using manipulative material in teaching geometrical concept has not been studied. The present study was a humble attempt to use tangram in teaching geometric concept at secondary level.

Statement of the Problem

Mathematics plays an important role in our daily life. For, this reason, the national education system plan (NESP 1971-1976) has emphasized in making mathematical teaching life oriented and practical.

Tangram constitutes the primary requirement of an effective teaching of geometry in the present day world. Using the tangram in the class is one of the ways to bring efficiency, effectives and meaningful understanding of the basis of secondary level mathematics in teaching of geometry. An improved and scientific tangram can

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make teaching more funny, interesting and meaningful, several educational meeting and seminars indicate that there is a great need for improving the qualities of education in the school of Nepal.

Most of the secondary school of Nepal are still using lecture and traditional method with the limited use of teaching aids. In order to make the mathematics teaching in geometry practical and life oriented, the teacher should follow learning by doing, learning by practical working and also use the instructional materials properly. Without use of necessary instruction materials, the teacher remains unable to make the mathematics teaching in geometry practical and effective. Therefore, the students, at secondary level, find difficult to understand geometrical concept. Tangram is the most familiar,cheapestand widely used teaching material in teaching of geometry. Hence this study intended to study effectiveness of the tangram in teaching mathematics at secondary level.

The statement of the problem has been "The effectiveness of the tangram in teaching mathematics at secondary level" The aim of this research is find out the answer of the following questions.

- Does the use of tangram in teaching mathematics more effective than without using it?
- What is the relationship between teaching mathematics and use of tangram at secondary level?

Objective of the Study

The main objectives of this study was to find out the effectiveness of the tangram in teaching mathematics at secondary level. This was accomplished by the following objectives:

- To compare the achievement of the student taught by using tangram and without using tangram.
- To find out the effectiveness of the tangram in teaching mathematics at secondary level.

Significance of the Study

Geometry is an integral part of mathematics in school curriculum, it gives the practical knowledge but due to lack of appropriate method and materials and large crowd class, students do not understand the concept properly, which leads them to get poor mark or cause them unsuccessful in mathematics. The lack of sufficient training and awareness toward using materials teachers have not been found comfortable in teaching geometry. Tangram is effective means to develop the concept and principles of geometry. As students go through the process of manipulation geometry become more permanent. Only the tangram is not sufficient, proper use of the tangram is stressed. Tangram is also manipulative material that can be used widely in teaching geometry at secondary level. This study has following significances.

- This study is given fun and entertainment for the teaching of geometrical concept and principles at secondary level.
- This study is provided students with opportunities to explore ideas, find the way of solving problem and various kinds of geometrical relationship.

- This study is helped for mathematics teachers and students of secondary level by providing more information about using tangram at secondary level.

Statement of Hypothesis

Research Hypothesis

The mean achievement score of the student taught by using the tangram is higher than the students taught by without using the tangram in teaching mathematics.

Null Hypothesis and alternative hypothesis

a) H_0 : There is no difference between the mean achievement score of experimental and control group on pre-test ($H_0 : \mu_1 = \mu_2$)

H_1: There is significant difference between the mean achievement score of experimental and control group on pre-test ($H_1 : \mu_1 \neq \mu_2$)

Where μ_1 and μ_2 are mean achievement score of students taught by using tangram and without using tangram in teaching mathematics.

b) H_0 : There is no difference between the mean achievement score of experimental and control group on post – test ($H :\mu_3 = \mu_4$)

H_1: There is significant difference between the mean achievement score of experimental and control group on post-test ($H_1 : \mu_3 \neq \mu_4$)

Where μ_3 and μ_4 are mean achievement score of students taught by using tangram and without using tangram in teaching mathematics.

Delimitation of the Study

The study was limited in the following aspects:

- The study was limited in two public secondary school of Sarlahi district.

- The study was limited to the effectiveness of tangram in teaching mathematics at grade IX.

- The study was focused on geometry teaching

- The teaching experiment was conduct for three weeks only.

- The sample was selected form grade IX students of Shree Aadarsha Janta Higher secondary school, Karmaiya-05, and Shree Janta secondary School, Dungrekhola-04, of Sarlahi district.

Definition of the Term

Achievement

In the reference to the present study, the term 'achievement' is defined in terms of the score obtained by the student on an achievement test prepared by the researcher.

Manipulative Material

Manipulative materials are any concrete object that can allow students to explore an idea in an active hands-on approach.

Tangram

Tangram is a logic game that develops spatial reasoning skill. It is made by the cutting of square plywood, carton or hand paper into seven piece of different geometrical figure (triangle, square and parallelograms). From the combination and

rearrangement of seven piece of geometrical figure, we can make different geometrical model or shape like triangles, parallelogram, rhombus, rectangle, etc. and other different figure.

Public School:

Public schools are those schools which receive the government grant for the salary of teacher and other purpose.

Effectiveness:

The degree to which objectives are achieved and the extend to which targeted problems are solved.

Chapter II

Review of Related Literature

Research takes advantage of the knowledge which has accumulated in the part as a result of constant human Endeavour. It can never undertake in isolation of the work that has already been done on the problem which are directly or indirectly related to a study proposed by a researcher. A careful review of the research Journals, books, dissertation thesis and other sources of information on the problem to be investigated in one of the important steps in the planning of any research study. Review of related literature helps the researcher to define his problem, avoid unfruitful and useless problem area, avoid unintentional duplication of well-established finding, understand the research methodology, know about the recommendation of previous researches listed in their studies for future research etc. Therefore the following review of the literatures supports the guideline for using manipulative materials in teaching mathematics at secondary level and fulfils the objectives of the study.

Amatya (1978), conducted a study entitled "A study of effectiveness of teaching mathematics with and without use of instructional materials" with the aim to find out whether instructional material were helpful to develop the mathematical concept and to measure the difference in concept development among students from Lalitpur Nagar Panchayat were selected by using systematic sampling and the experiment was conducted four weeks duration. It was concluded that the mean differences was significant at 0.05 levels. The conclusion was that the performance of the students taught with use of instructional material was significantly improved when

compared with the performance of the students taught without use of instructional materials.

Baral (2005), did a study on "The effectiveness of instructional materials in teaching geometry at primary level" The researcher studies primary level (class V) students. Instructional materials were used with experimental group to teach geometry unit. The same unit was taught to control group using the text and traditional instruction. The study was conducted over a period of 20 days. Using t-test, the researcher conducted that the experimental group scored significantly higher than the control group.

Ghimire (2001) did a research on the topic" a study on the impact of experimental verification in Teaching the Deductive proofs of Geometric Theorem" with the aim to the study of effect of prior use of experimental verification in proving the geometric theorem. The study was conducted between 30 ninth grade students of two different schools for 15 days. At the end of the experimentation time an achievement test was conducted and the cores were analyzed by using t-test with 0.05 level of significance. He concluded that there was a good effect of the prior use of experimental verification in proving the geometric theorem.

Adan (2010) did a research on the topic" The experimental teaching in some of topics geometry". The aim of this study was to compare the experimental teaching method with the teacher centred traditional teaching method based on students' success. The study has conducted with 54 students randomly divided into two groups; an experimental group and control group. Experiment teaching method was used for experimental group and traditional teaching method was used for control group. The experiment was conducted for three weeks. At end of the experimentation time an

achievement test was conducted and the scores were analyzed by using t-test at 0.05 level of significance. According to the research result, it was found that experimental teaching method was more effective than teacher-centred traditional teaching method in the knowledge and comprehension level.

Lamsal(2004) did an experimental research on " A study on Effectiveness of problem solving approach in Teaching Menstruation at secondary level Mathematics of grade IX students with the aim to compare the achievement of students taught by problem solving approach. A post- test equivalent group design was adopted to conduct the experiment in concept of menstruation of grade IX for four weeks. Sample of 58 students (31 boys and 27 girls) were taken and the developed test consisting 30 items was used for achievement test. At the end of experiment period, an achievement test was conducted and the scores were analyzed by using t-test with 0.05 level of significance. He concluded that the achievement of students taught by problem solving approach of teaching improved significantly better achievement than the students taught by traditional approach.

Ernest (1994), conducted a study on "Evaluation of the effectiveness and implementation of math manipulative." The study consisted of 40 high school teachers from 26 schools. The teachers attended the weekly long training workshop in the use of manipulative implemented the teacher strategies discussed during the workshop in their classroom instruction during the following years, then intended a fellow up session to discuss strategies and problems identified during the implementation phase of the study. Data was gathered to evaluate the weeklong teaching training workshop and implementation of manipulative in classroom instruction. On- site observation were conducted to record utilization by course and manipulative, students participation, students attitude towards manipulative and

interaction with the content. Evaluation of the workshop reviled that the teacher found the quality of instruction to be excellent to very good. Evaluation of the math manipulative and that 'on task' involvement was very high. Teacher reported that the students enjoyed and were more interested in assignment when manipulative were used.

Garity (1988), did a study on topic "Does the use of Hands on learning with manipulative improvement the test score of geometry student? This study documented the difficulties of high school students to visualize and understand geometric problem which included the manipulative co-operative learning and real life problem solving. This study was conducted with 47 sophomore students enrolled in two high school geometry classes. One group was considered the control group and second was the experimental group which was taught using the manipulative Research method included student and parent service teacher created quizzes and tests, teacher's observation and interviews. The researcher concluded that score of the experimental group was higher than the score of control groups. Thus, the traditional teaching method is less effective than using manipulative.

Kunwar (1997), did an experimental study on "The effectiveness of utilizing materials in teaching geometry in a selected lower secondary class (VI)." The use of visual aid and materials helped pupils (both boys and girls) to understand geometry and consequently perform better in an achievement test. The use of visual aids helped pupils to apply geometry in everyday life, very slight interaction between the visual aid and sex of the pupils existed. Otherwise, pupils of the sexes benefited in cognizing the concept of geometry when taught by using visual aids.

In Nepal, some studies have been done to explore whether the achievement in mathematics is affected by class size, sex factor, teacher's qualification, ethnic groups and use of instructional materials. Some studies concerning scholastic achievement and child development in secondary level or any particular in secondary level. The present study differs from those of the existing researches in the sense that it deals with effectiveness of particular materials the widely used instructional materials in teaching mathematics.

CHAPTER – III

METHOD AND PROCEDURE

This chapter describes the design of the plan and procedure of the study which was carryout to achieve the objective of this study. Research methodology is a science, which determines how the research becomes complete and systematic. This chapter deals with how the methodology of study was determined. It presents how the sampling of study was determined, how the sampling was done, how the data collection, instruments were develop, how the instruments were administered to the target group. It also presents how the collected information was translated into meaningful statistics.

Design of the Study

The pre-test, post-test, non-equivalent group design (experimental design) was adopted for the purpose of this study. The paradigm of the study is as follows:

Groups	Pre-test	Treatment	Post-test
Control group	T_1	Traditional method (without using tangram	T_2
Experimental group	T_1	New Method (with using tangram)	T_2

Where,

T_1= Pre-test given to the students (Experimental and control group)

T_2 = Post-test given to the students (experimental and control groups)

In this study, there were two groups experimental and control group. Experimental group was taught by using tangram whereas control group was taught without using tangram. This design was the most effective to the minimizing the threats to external validity. Two groups were made homogeneous as nearly as possible by selecting school of similar status with respect to physical facilities and pre-test achievement for experimental and control groups. These groups were compared on pre-test score by t-test, the t-test comparison indicated that the groups were comparable at the 0.01 level of significance.

Population of the Study

The population of the study was consisted of all students of grade IX in public secondary school of Sarlahi district.

Sample of the Study

The researcher selected purposively two public schools of Sarlahi district as sample. They were Shree Aadarsha Janta Higher Secondary School, Karmaiy-05 (SAJHSS) and Shree Janta secondary school, Dungrekhola -04 (SJSS) . According to school register, there were 39 students in (SAJHSS) and 36 students of (SJSS) in grade IX. The selection of experimental group or control group was made by tossing a fair coin. All the students in class nine was considered while conducting the classes, but only equal size (twenty students in each group) of students from each group was considered for the study.

This was done for two reasons: The first was to equate the group on sample size; the second was to drop irregular and repeated students from the sample. Thus,

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the final sample considered in the study was forty (twenty students in each experimental and control group).

Instructional Tools

An achievement test prepared by the researcher was the main instruments of collecting data for this study. Which was the type of instrument to be used depending upon the objectives of the study. As mentioned above the present study aimed at looking into how the manipulative materials facilitate teaching geometry at secondary level. Obviously, the researcher needed to use of subjective type instruments. The achievement test was based on the geometry at grade IX.

Construction of the Achievement Test

An achievement test was the main tool for the data collection of this study. The researcher developed the pre-test question on the basis of grade IX content to select the sample from the required schools. For the question of post-test examination, questions were developed by the researcher according to teacher's guide and specification grid of grade IX of geometry portion which were published from CDC Sanothimi, Bhaktpur. Pilot study was adopted to establish the validity and reliability of the test item (see appendix-II). For the pilot study twenty questions were kept. Among them nine were short answer type question each with marks 2 and eight were long answer type question each with marks 4. After analysis the pilot study 17 items were accepted and 3 were rejected (see appendix III). The allocated time to the test was 2 hours which was stipulated based on the calculation of average time taken by the student in pilot testing. The different mathematics achievement test was used for pre-test and post-test treatment.

Construction and Validation of Instruction Instrument

The researcher developed teaching episode for experimental group. Teaching episode for experimental group was developed by using tangram material which is given in Appendix-VIII. For reliability and validity, it was checked by the supervisor and subject expert.

Observation

During his classroom teaching, the researcher noted the student's participation, interaction, performance, homework, regularity in class and interest on subject matter which reflects the effectiveness of Tangram in teaching mathematics at secondary level.

Term Analysis of the Test

In item analysis, the difficulty level (p-value) and discrimination index (d-value) of the test was computed to check the quality of the test item. Test item were analysed to examine their power to separate the more from less capable students in performing the test task. This was done by calculating the response of the 27 percent of student who scored high and 27 percent of students who scored low. So, the researcher took six upper and six lower scores students out of twenty students. A test item is said to be good if it is correctly done by the top students and not by the bottom students. This is how a test item discriminates from more to less capable students. The calculation of discrimination index (D-vale) of the test item was done on the basis of this kind of analysis. The table of item analysis of test is given in Appendix III.

Taking into account the obtained the level of difficulty (p-value) and index of discrimination (D-value) of each item, only these items were selected whose P-value

was ranging between 30% to 70% and D-value was ranging between 0.20 to 0.80 the other items were rejected and modified. The three items (1 short and 2 long) were rejected after item analysis, so, only 17 items were chosen for the achievement test items (Appendix –III) the difficulty level (p-value) and the discrimination index (D-value) are defined by the formula. (Appendix – VII).

Reliability of the Test

Reliability is the degree to which consistently measures whatever it measures. The repeated administration of the test is essentially same, then we can have that the score obtained from the test is confidently more reliable. To establish the reliability, pilot study was made to 20 students of grade IX of Shree Chaturvajeswor H.S.S. Sukhepokhari, Sarlahi. Before administering the test paper, researcher gave instruction about how to answer the given questions. The reliability of the test subjective questionnaire is established by spilt half method and found that its value was 0.83. It indicates that the test was reliable (Appendix IV)

Validity of the Test

Validity is a degree to which a test measures what it is supposed to measure. A test is valid for a particular purpose and a particular group. Therefore, this mathematics achievement test was prepared for measuring the achievement of grade IX students. To maintain the content validity for this test, the researcher used curriculum, textbook and teacher's guide when established achievements test paper. To develop this paper, school's subject teacher and supervisors helped him. The test paper covered all contents according to their weightage. The test measured what it supposed to measure. It indicates that the test had content validity.

Internal and External Validity Threats and Their Control

The possible threats on the internal validity in the current study were location, history, instrument decay, maturation, regression, researcher characteristics and his bias.

The location and history threats were controlled by administering the pre- test and post test at the same time. The physical and geographical locations were not different since the both school choosen at the same place. Since all the students are taken from the same level, grade IX. The maturation bias was not the threats for this study because the researcher followed the same knowledge and behaviour, emotion and strategies in both group except manipulative materials.

Certain extraneous variable cannot be controlled directly like as subject matter taught, evaluation applied, teacher variables and equating the group were controlled by the special procedures.

For this, the following exercises were done to control variable. Same content was taught to both the experimental and control groups from the same curriculum, same textbook prescribed by government of Nepal. After the end of the experiment the same test was given to experimental and control groups. The researcher himself marked the test paper of the students. So, the variation in marking of the test paper was also reduced. In this study, the experimental and control group were equal with respect to school grading and pre-test score. Both schools were equally reputed in terms of result. To check the equivalence, the researcher calculated correlation coefficient $r_{xy}= 0.83$ on the basis of pre-testscore. The researcher calculated F- statics to check the homogeneity of the variance and T- statistics to check the mean difference of two groups. By these conditions researcher claimed that two groups

were equivalent. Finally, by tossing a coin he selected experimental and control group.

Data Collection Procedure

The procedure of data collection describes how the relevant information was gathered. A study is mainly based on quantitative data obtained from the achievement test. In addition, quantitative data, some qualitative information was taken in relation to students' progress while conducting actual classroom teaching. After the standardization of the test, the collection of data from achievement test was done by the following process. Prior to administration of achievement test, the researcher meet the headmaster, subject teacher, and took permission for the test in school. Then students were informed the way to respond the items then the test was administrated students of SAJHSS and SJSS on same day in different period. The duration of 2 hours was allocated to the students to take the test. This time allotment was determined by students during pilot testing. After allocating and scoring all answer sheets, the score were tabulated. The score on the test ranged from 20 to 47 out of full marks 50.

For the sake of qualitative information on students learning progress (With learning difficulties), the researcher maintained daily notes in brief the significance features such as participation, performance, integration, homework, discussion and problem solving, students regularly and their interesting. The main focus on how the tangram was effective in teaching mathematics. So, the data was collected to address student's difficulties in learning geometry and to facilitate students' progress by using tangram.

Phase of experiment of the study

Pre experimental phase

The researcher selected two groups (experimental and control group) and made homogeneous as nearly as possible by selecting school of similar status with respect to physical facilities, academic achievements, class size, teacher's qualification and experience for experimental and control group. The researcher developed the pre-test question on the basis of curriculum, teacher's guide and specification grid of grade IX of geometry portion. Pilot study was adopted to establish the reliability and validity of the test.

Experimental Phase

In this phase, different type of extraneous variable can affect the research activity. So to ensure the effect of the independent variable on dependent variable, researcher controlled some variable such as maturation, history, testing effect, time interval and statistical regression, researcher taught to both experimental and control group the same curriculum, same text book, for same time of duration. He taught experimental group with using tangram and control group without using tangram.

Post Experimental Phase

After three weeks of experiment, a post-test was administered on the both group. The answer sheet was collected and process manually for scoring by researcher himself. After that, the mean achievement, standard deviation, t-statistics were calculated.

Data Analysis Procedure

The researcher analysed and interpreted the collected data by following procedures.

- Mean, standard deviation and variance were calculated for both groups with their secured marks in the test.

- t-test for independent sample was used at 0.01 level of significance to find whether the difference between means was statically significant by using the method of pooled variance formula as given in appendix VII. When the samples are small and variance are equal nearly we can use the method of pooled variance to test the significance difference between independent means, the critical value of t-test be found for N1+N2 -2 degree of freedom.

- Homogeneity of variance (F) was tasted by using statistical formula given in appendix VII.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

The study was experimental in nature. The achievement test was the basic tool for data collection. The study was intended to explore the effect of the manipulative material in teaching geometry. The effect of manipulative material has been assessed on the basis of post-test scores obtained by experimental and control group. The group were compared on pre-test scores. So, as to compare at the beginning of the experiment. The analysis has been made under the following headings:

Analysis of Pre-Test Result

Score of the pre-test of students of the experimental and control group have been given in appendix – VI together with the statistical calculation of mean, standard deviation, and variance, the t-test analysis for the comparison of the mean achievement scores of pre-test has been summarized in the following table.

Table No. 4.1

Comparison of experimental and control groups on pre test scores

Group	N	Mean	Standard deviation	Variance	F	t-value	r
Experimental	20	29.7	4.66	21.71			
Control	20	28.85	4.44	19.68	1.10	0.59	0.99

$t_{0.005,38} = 2.57$ at $\alpha = 0.01$

The table 4.1 reveals that mean, variance and standard deviation of pre-test score of experimental and control groups are 29.7, 21.71, 4.66 and 28.85, 19.68, 4.44 respectively. The mean scores indicate that the experimental group is better than that of control group. But the result of the t-test indicated that there were no significant differences between the groups on pre-test scores. F- test indicates that the variance were homogeneous which means that the group were comparable in pre-test scores. Also, the correlation coefficient indicates that the correlation between the achievement of experimental and control group is substantial.

Homogeneity of the Variance

To the test of homogeneity of the variances, the researcher calculates value of F. The calculated value (F= 1.10) is less than the tabulated value (F=3.00), it indicates that the variance are homogeneous to each other. Statistical formula are described in appendix – VII.

The mean achievement score of both groups were compared statically using two tailed t-test at 0.01 level of significance. The calculated value of t-test was 0.59 which is less than the tabulated value of 2.57 at 0.01 level of significance with degree of freedom 38. So, the null hypothesis is accepted. Therefore there is no difference existed between the experimental and control group on pre-test score.

Figure No. 1

Comparative Bar graph Showing Achievement of Experimental and Control Group in Pre-Test.
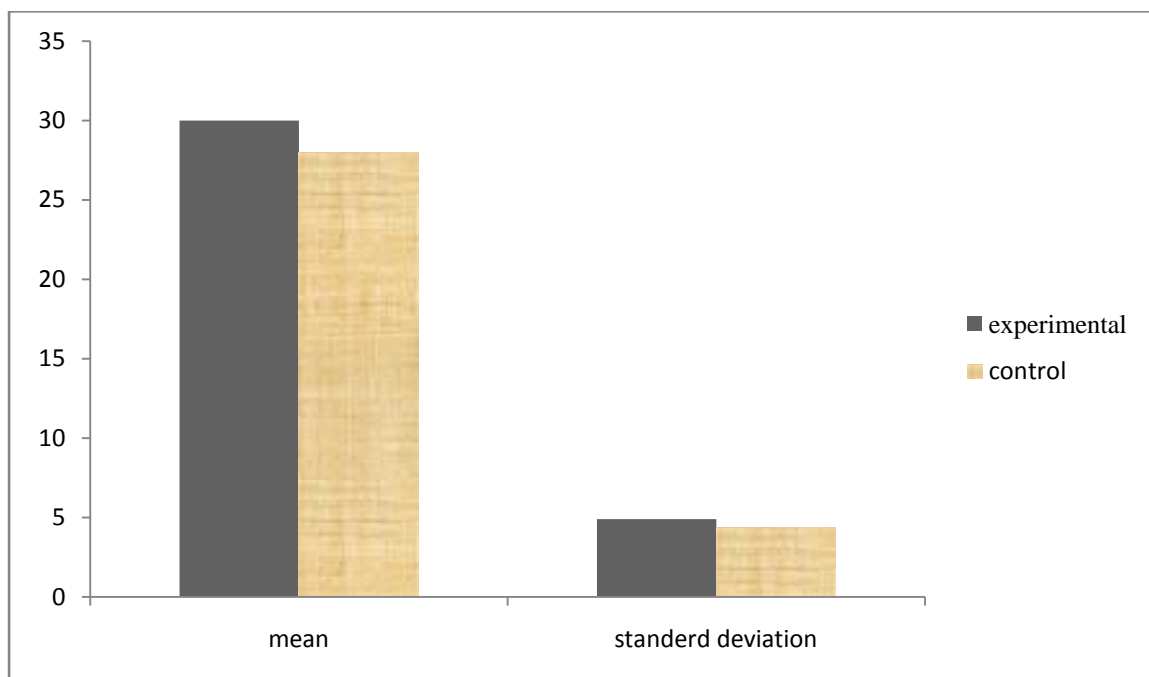
The figure No. 1 shows the mean and standard deviation scores obtained from both experimental and control groups in pre-test. The diagram indicates that there is no significant difference between mean and standard deviation obtained from the achievement scores in teaching geometry of both groups.

Analysis of Post Test Result

The post-test was administered to both experimental and control group after the treatment was given. The post-test score of students of experimental and control groups have been presented in Appendix VI. The calculation has also been made to calculate t-value as mentioned in Appendix VII. The summary of the test analysis for the comparison of mean score of experimental and control groups on post-test have been given in table 4.2.

Table No. 4.2.

Comparison Between Experimental and Control Group on Post Test Scores.

Group	N	Mean	Standard deviation	Variance	t-value	F-value
Experimental	20	38.7	6.22	38.71		
Control	20	31.2	5.93	35.21	3.9	1.099

$t_{0.005,38} = 2.57$ at $\alpha = 0.01$

The table no 4.2 indicates that both mean and standard deviation of both group are different. The score of experimental group ranged from twenty three to forty seven with mean score 38.7 and score of control group ranged from twenty to forty with mean score 31.2 and standard deviation are 6.22 and 5.31 respectively. The difference in mean between experimental and control group is 7.5. The t-test analysis indicated the difference in mean are found significant at 0.01 of significance. So, the result of the t-test analysis does not support the null hypothesis of the existence of the difference (in favour of experimental group). That is, the test indicated that the students in experimental group out performed than students of control group on post-test scores. This indicates that the students of experimental group are significantly benefited in the achievement of teaching geometry than the students of control group. Thus, the researcher concludes that the achievement of grade IX students who were taught geometry with using tangram, achieved better achievement than the students who were taught without using tangram

Figure No. 2

Comparative Bar Diagram Showing Achievement of Experimental and Control Group on Post-Test Result.
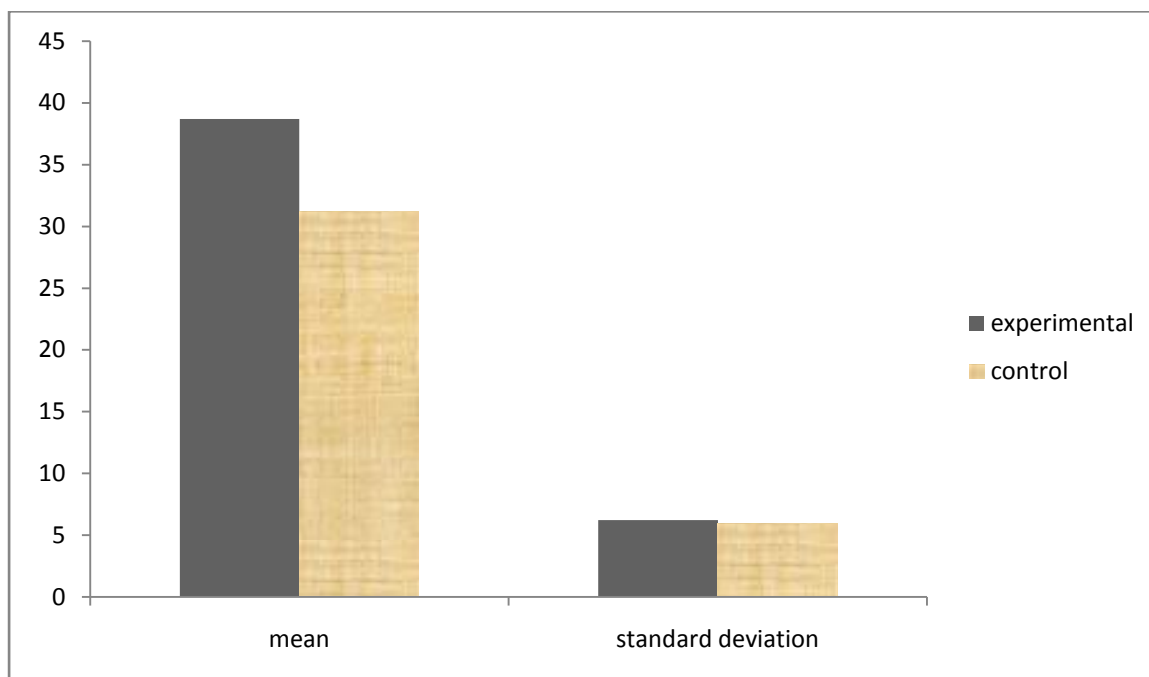
The figure no. 2 indicates that mean and standard deviation scores obtained by the students of experimental and control group. In the post-test, the mean scores of experimental group is 38.71 and control group is 31.21. Therefore, the mean score of the experimental group is greater than the control group. This result indicated that the experimental group has better result than that of control group. Hence, the achievement of the students taught by using tangram is better than the achievements of the students are taught without using tangram.

Qualitative Analysis

Qualitative analysis was made on the basis of observation made by the researcher. On the basis of classroom instruction the researcher observed the students activities noted daily on his notebook. Experience from tangram helped them learn

basic concept of geometry and properties of geometric laws. Students' works in group

or individually explored and investigated the problem and they constructed, tasted,

compared and justified the geometrical concepts in Tangram. Tangram helped them

challenged to find alternative solution. It helped them to communicate their thinking

in geometry.

CHAPTER -V

SUMMARY, FINDINGS, CONCLUSIONS, RECOMMENDATION AND SUGGESTIONS

This chapter is basically concerned on the summary, findings, conclusions and recommendations, of experimental study for finding the effectiveness of tangram in teaching mathematics at secondary level students.

Summary of the Study

The study is an experimental in nature. The study was concerned with the study of the "Effectiveness of tangram in teaching mathematics at secondary level." The dependent variable in this study was achievement in mathematics and independent variable was the use of tangram in teaching mathematics at secondary level. This study was intended to answer whether the use of tangram yields better achievement of students than without using it while teaching geometry at secondary level. This study utilized the pre-test post-test non-equivalent group design. This study conducted at grade IX of government school. The study was conducted in Shree AdarshaJanta higher secondary school, Karmaiya – 05, sarlahi with a total of 39 ninth grade students and Shree Janta Secondary School Dungrekhola -04, Sarlahi with a total of 36ninth grade students. A pre-test was administered to each class at the beginning of the study and the researcher was made comparable groups by one to one corresponding on the basis of pre-test score. There were 20 students for experimental group and 20 students for control group.

Achievement test was the main tool to assess achievement of students and class note were used to collect information. The achievement test was pilot tested with

20 students in Shree Chaturvujeswor H.S.S Suhkepokhari, Sarlahi. Item analysis and reliability of the test score were calculated on the basis of the test score. It was determine through the application of spit half reliability calculation. The test was validated with respect to content facts to be covered and consulting with supervisor, experts, and other researchers. According to the result of this pilot study, the test was revised and achievement test was administered both as pre-test and post-test.

The duration of the study was three weeks. Post-test was administered to both group in order to make comparable group for experiment. Experimental group was taught by using tangram and control group was taught by traditional method. Both groups weretaught the same unit. After the completion of teaching on both experimental and control groups, post-test was administered. The researcher himself taught both group twenty one days. During experimental period, researcher used to maintain daily note on students understanding, participations, preparation, class regularity, interesting, motivation and performance etc. The data obtained from the pre-test, post-test and daily notes.

The mean achievement of experimental group on post-test was greater than that of the control group. Student's t-test comparison of the mean score on post-test indicated that difference was significant at 0.01 level. The t-test comparison of mean scores on pre-test indicated that the group were not significantly different before post-test. It was concluded that the mean achievement score of the students taught by using tangram was better than the mean achievement score of students taught without using tangram in teaching mathematics at secondary level.

Findings of the Study

On the basis of achievement test of students and remarkable features on students classroom activities while using tangram (manipulative materials) the researcher drew following information.

- The achievement of grade IX students who were taught geometry with using manipulative materials (Tangram) achieved higher mean achievement than the students who were taught without using manipulative materials (Tangram).
- The students of experimental group were highly interested and curious in teaching and learning process than that of control group.
- Manipulation of tangram regularly played a vital role in teaching geometry. The use of tangram found more flexible in presenting geometrical figures and identifying properties comparison to the use of blackboard in control group.

Conclusion

From the result of this study the researcher found that the mean achievement score of students taught with using tangram was higher than the mean achievement score of students taught without using Tangram. So, using of tangram helps students in creating definition and conjectures, to develop meaningful understanding of geometric concept and properties and also gaining insight into new geometrical relationships and inter-relationships in secondary level, manipulative materials make the teaching interesting and funny. So, students were motivated. Thus, we should use tangram to teach geometry at secondary school.

Recommendation

On the basis of this study, the following recommendation has been made in respect of teaching geometry at secondary level.

- Before going to classroom, every teacher should be confident in how to use tangram.

- Tangram should be used frequently in teaching geometry in a way consist with the goal of the program.

- Tangram should be used to develop the geometrical ideas and concepts.

- Tangram should be used to create a task that causes students to see conflict or gaps in their thinking about geometry.

Suggestion for Further Study

On the basis of this study, the following suggestions have put forward for future study.

I.   This study was confined only on Sarlahi district therefore, further study should be done in different district.

II. More extensive research studies must be designed and carried out in investigate the effectiveness of the use of tangram materials in teaching geometry in large sample and various schools of different part of Nepal.

III. It should be worthwhile to study the opinion and attitudes of the teacher and pupils towards the manipulative materials.

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Subject: Mathematics   **Name of School:**

Class: IX   **Time: 2 hrs.**

Question for pre-test

Group A

1) Calculate the value of 'a' and b in the following figures and find the unknown angles.

a)

b)
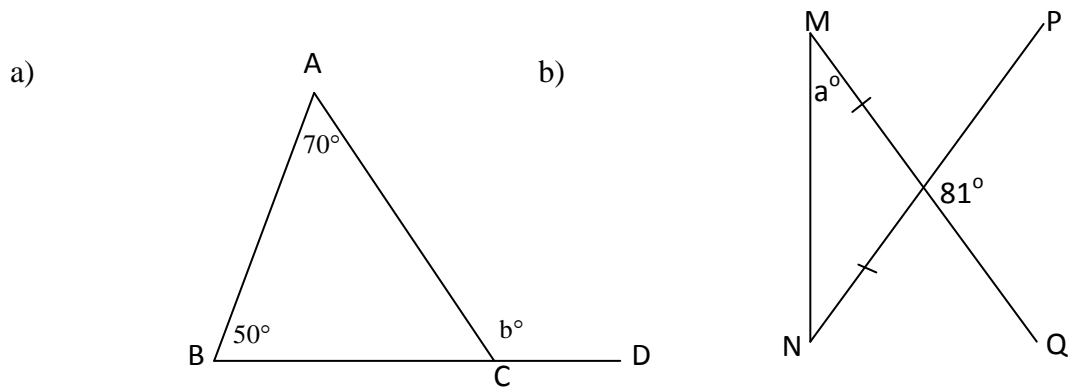
2) Find the value of p and q

a)

b)
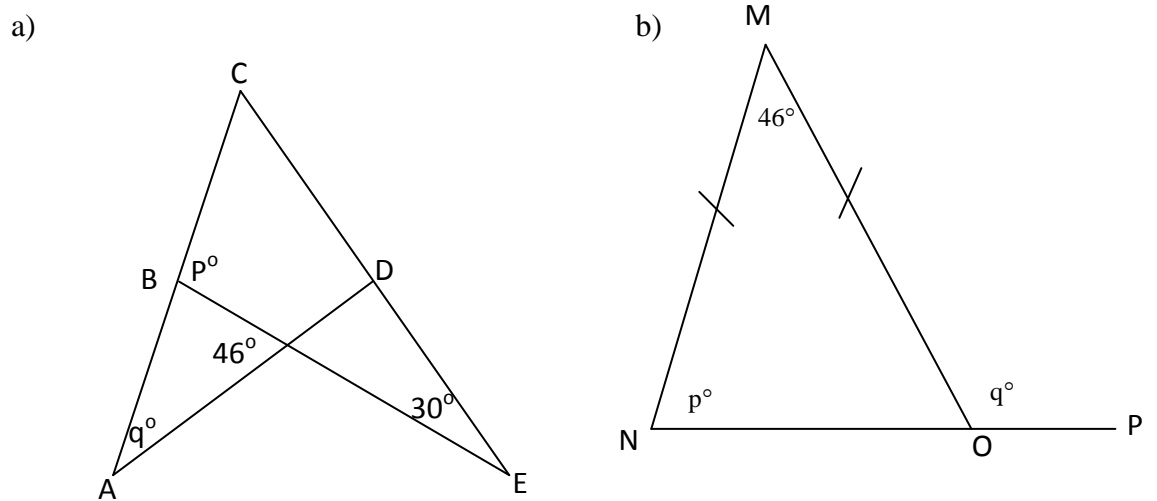
3) Find the value of a in the given figure.
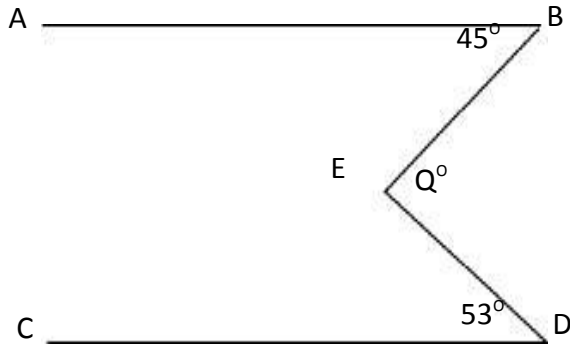
4)In the adjoining figure, find the unknown size of angles
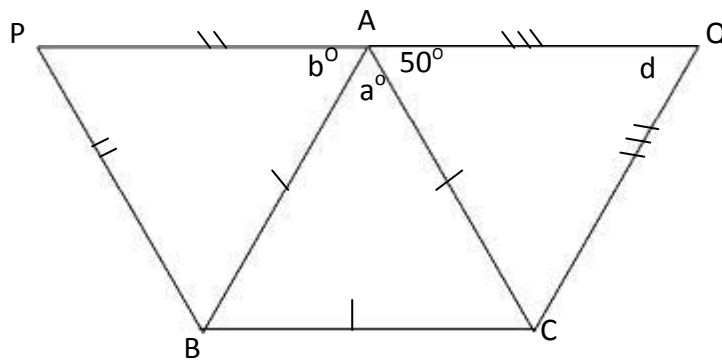
5) Calculate the size of unknown angles.

a)

b)
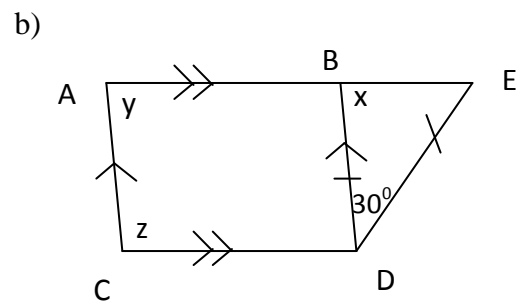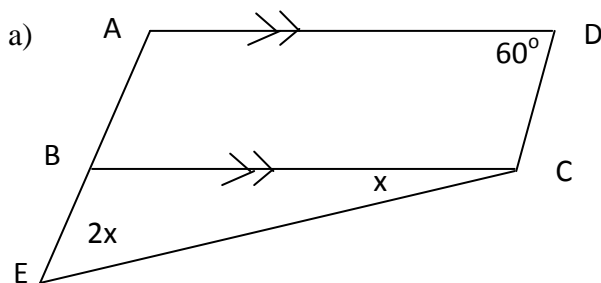
6) In the adjoining figure ABCD is a parallelogram. Find the size of x,y and z.
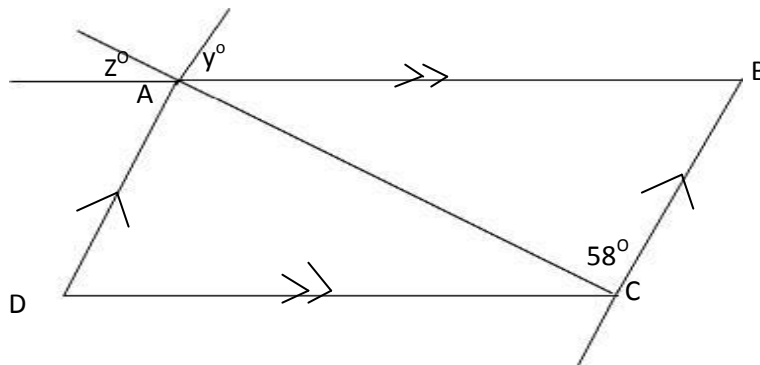
7) If any two sides of a triangle are equal the opposite angle to them are equal. Prove that theoretically.

Group B

8) Prove that the diagonal of parallelogram bisects each other

9) A straight line segment through the midpoint of one side of a triangle and parallel to another side bisect the third side. Prove experimentally. (at least three triangles, is necessary).

10) In PQR, A, B, and C are midpoint of PQ, QR and PR respectively, Find the size of angle represented by latter.
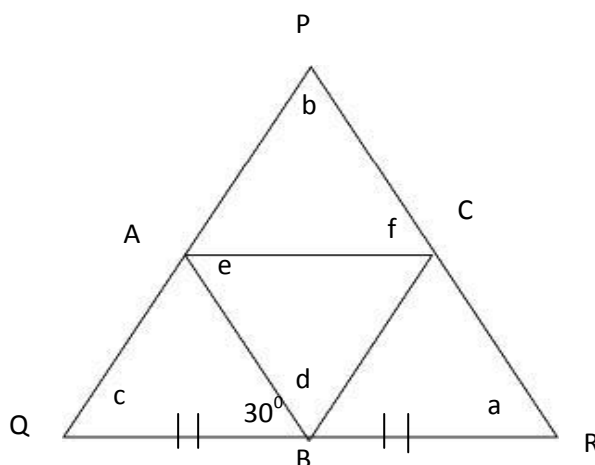
11) Prove that "The straight line segments that joints the end of two equal and parallel line segment towards the same sides are also equal and parallel.

12) In the figure, ABCD is a parallelogram, AP bisects < A prove that DP=BC
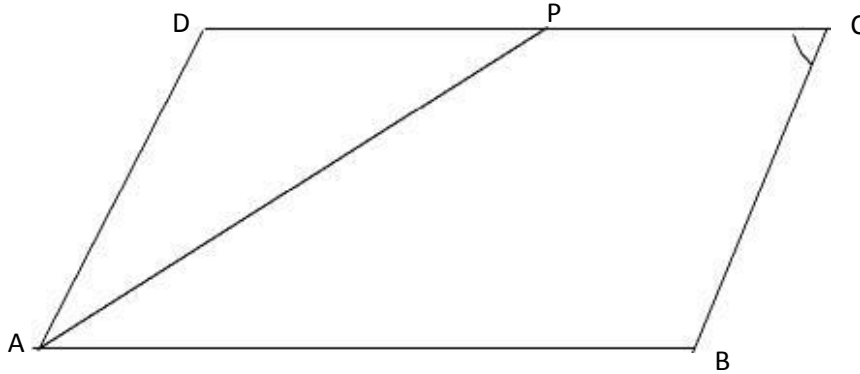
13) Prove that opposite angels and sides of a parallelogram are equal.

14) In given parallelogram PQRS, M and N are the midpoint of the sides PQ and SR respectively. Prove that

I)   PNRM is a parallelogram

II)   QA = AB = BS
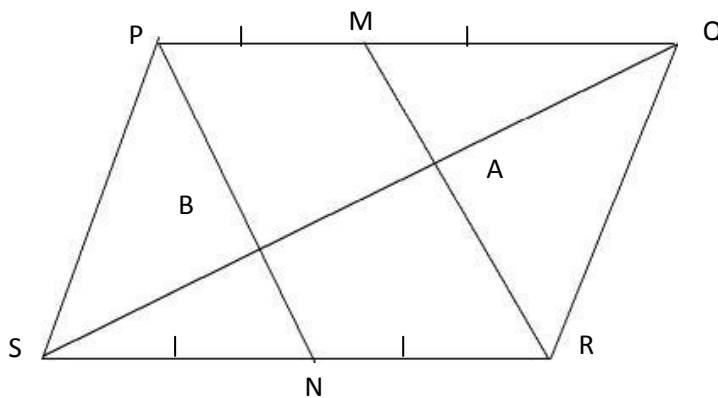
15) Prove that "The bisector of the vertical angle of an isosceles triangle is the perpendicular bisector of the base.

16)   In the adjoining figure, P,Q,R and S are the midpoint of AB, BC, CD and AD respectively. Prove that PQRS is a parallelogram.
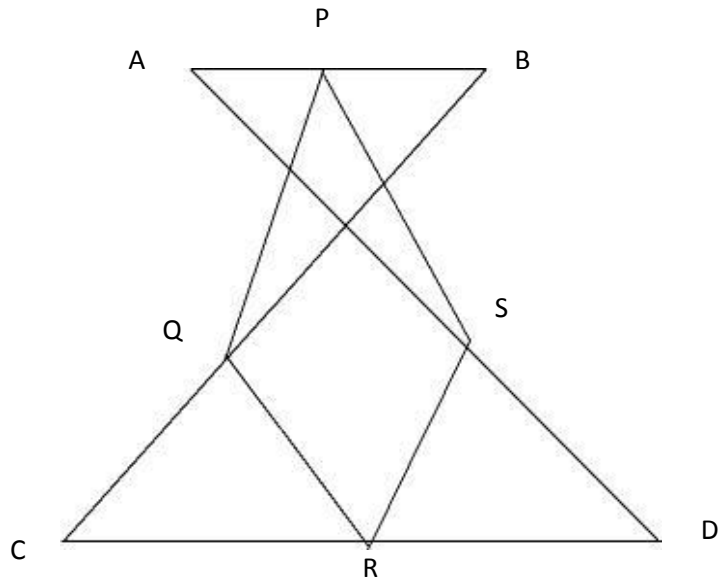
Question for item analysis

Subject: Mathematics   **Class: 2 hrs.**

Name of school: **Time: 2 hrs.**

Group A

1) A) If X^0 25^0 and 80^0 are the angles of triangle. Find the size of x^0

B) If P^0, $2p^0$ and 30^0 are the angle of a triangle. Find the unknown size of angle of the

   triangle.

2) Find the unknown size of angles

a)b)
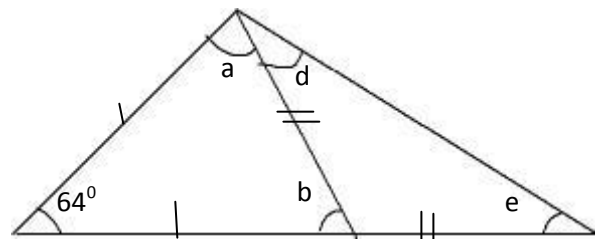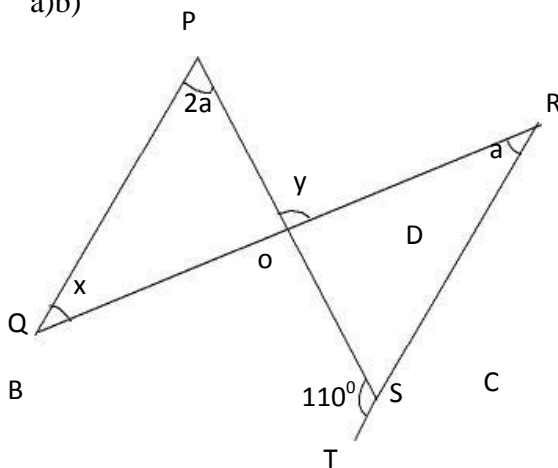
3) In the given figure, AB=AC, BD is the bisector of ABC of ABC $=35^0$ find ABD.

41
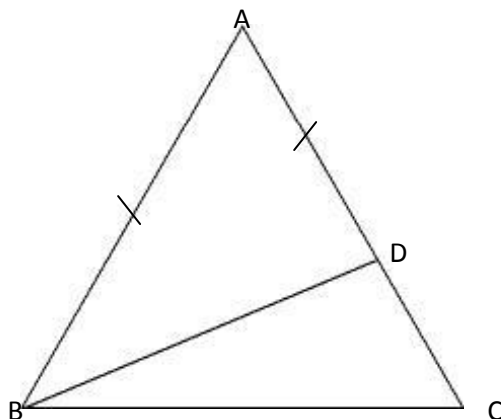
4) ABC is an isosceles triangle in which AB=AC.AB bisects CAE that AD parallel BC.
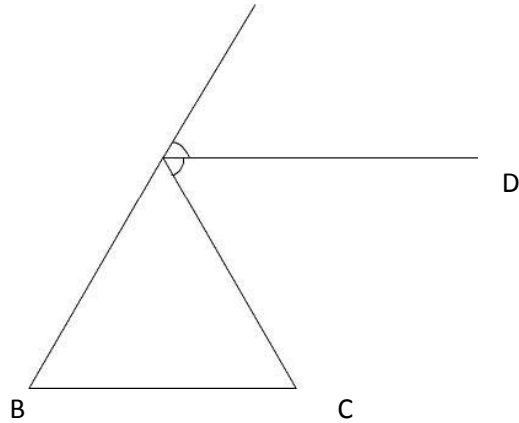
5) From the given figure, prove that $<BAC + <ABC = <ACD$
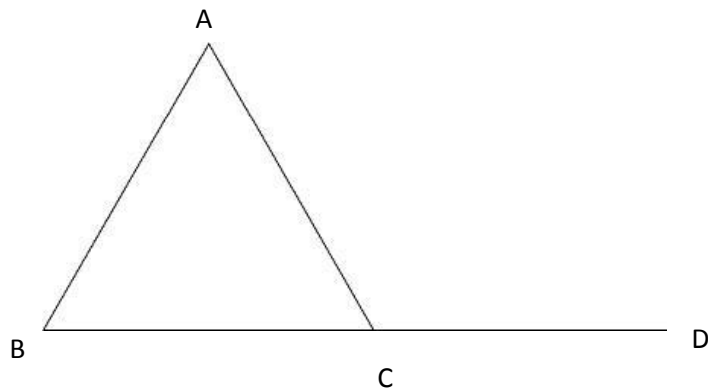
6) Prove that "The sum of three angles of triangles is equal to two right angles.

7) Base angles of isosceles triangles are equal. Prove experimentally, [at least three triangles are necessary]

8) In the given figure, PAB=QAC, AP=AQ and PB=QC.

Prove that ABC is an isosceles triangles.
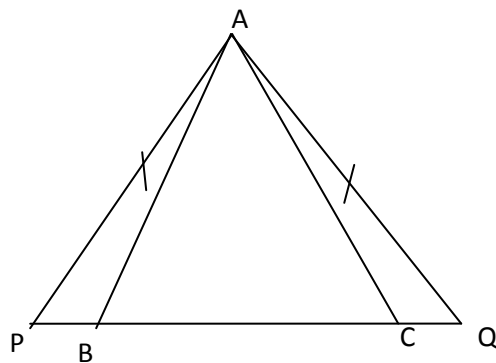
9) Find the value of a and y in the given below with geometrical reason
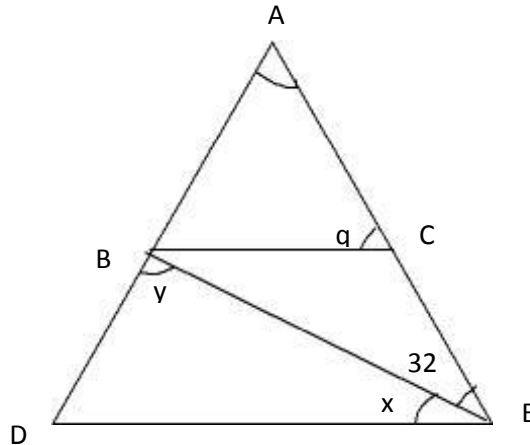
10) In the given figure <ABC is an isosceles triangle. BO and CO arebisector of ABC and ACB respectively. Then, prove that BOC is an isosceles triangles.
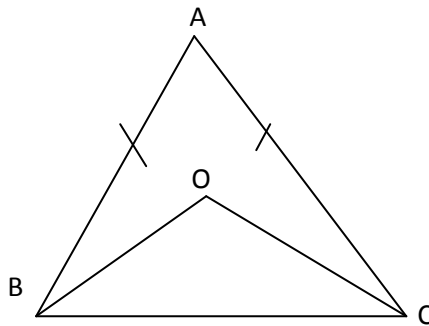
Group B

11) Prove that the diagonals of a parallelogram biscect each other.

12) In given figure, AB is parallel to CD, BE= ED and AF = FD. If EF is embedded then it cuts AC at G. Prove that AG=GC.
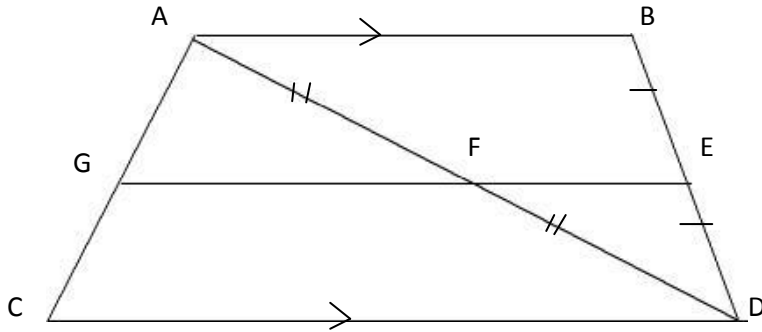
13) Prove that diagonals of a parallelogram bisect each other are equal.

14) P,Q, R and S are the mid points of one sides AB,BC, CD and DA of the quadrilateral ABCD respectively. Prove that PQRS is a parallelogram.
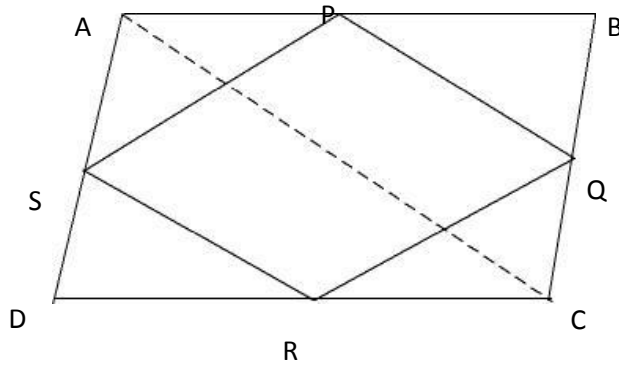
15) In the figure alongside, ABCD is a parallelogram. If 2MO=OD, prove that M is midpoint of BC.

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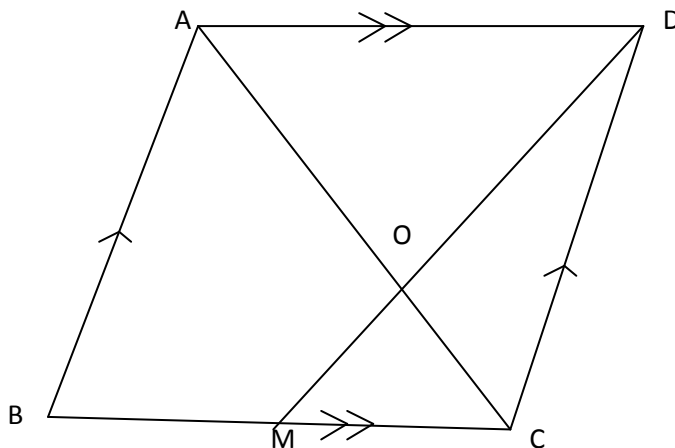
16) Prove that the line segment joining midpoint of any two sides of a triangle is parallel to the third side and is half of it.

17) Prove that the diagonal of a parallelogram divides it into two congruent triangles.

18) In the adjoining figure, ABCD is a rhombus in which BA is produced to E such that BA= AE. Prove that EDB= 90^0
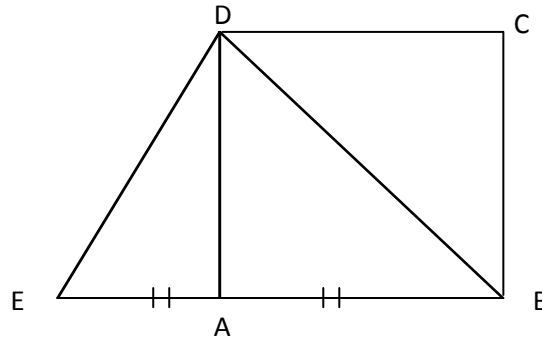
19) In the given figure, ABCD is a parallelogram, B = 78^0 and AE=AD. Find the measures of EDC
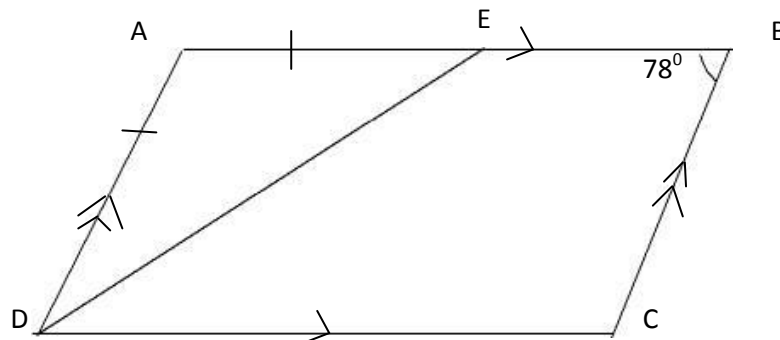
20) In the figure ABCD is a square and BEC is an equilateral triangles. Find AEC and DAE.
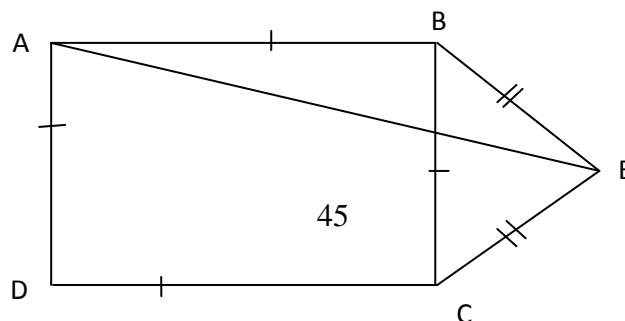
Item Analysis

Students Items	Upper 27% students giving correct response								Lower 27% students giving correct response							P-value	D-value	Remark
	1	2	3	4	5	6	Total		1	2	3	4	5	6	Total			
1	1	0	1	1	0	1	4		0	1	0	0	1	0	2	50%	0.33	A
2	1	1	0	0	1	1	4		1	0	0	0	0	1	2	50%	0.33	A
3	1	1	1	1	1	1	6		0	0	1	1	0	0	2	66.66%	0.66	A
4	0	1	1	1	1	0	4		0	0	1	1	0	0	2	50%	0.33	A
5	1	1	1	1	1	1	6		1	1	0	1	1	1	5	91.66%	0.16	C
6	1	0	1	1	0	1	4		0	1	1	0	0	0	2	50%	0.33	A
7	1	1	0	1	1	1	5		0	0	1	0	0	0	1	50%	0.66	A
8	0	1	1	1	1	1	5		0	1	0	0	0	1	2	58.33%	0.5	A
9	1	0	1	0	1	1	4		1	0	1	0	0	0	2	50%	0.33	A
10	1	1	0	1	1	1	5		1	0	1	0	0	0	2	58.33%	0.5	A
11	1	1	1	1	0	0	4		0	1	0	0	0	0	1	41.66%	0.5	A
12	1	1	1	1	1	1	6		0	0	0	1	0	1	2	60.66%	0.66	A
13	0	0	1	1	1	1	4		0	0	1	0	1	0	2	50%	0.33	A
14	1	1	0	0	1	1	4		1	1	0	0	0	0	2	50%	0.33	A
15	0	0	1	1	0	0	2		0	0	0	1	0	0	1	2.5%	0.16	C
16	1	1	1	1	0	1	5		0	0	0	0	0	1	1	50%	0.66	A
17	1	1	0	0	1	1	4		0	0	1	0	0	1	2	50%	0.33	A
18	0	1	0	0	1	0	2		0	0	0	0	1	0	1	25%	0.16	C

19	0	1	1	1	1	1	5		1	1	0	0	0	0	2	58.33%	0.5	A
20	1	0	1	1	0	1	4		1	0	0	1	0	0	2	50%	0.33	A
Odd Sum (Xo)	7	6	8	8	7	8			2	4	4	4	4	2				
Even sum (Xe)	7	8	6	7	7	8			5	6	6	6	1	4				
Total	14	14	14	15	14	16			7	7	7	7	5	6				

Appendix IV

Spilt half reliability test

Odd(X_0_	Even(X_e)	X_0X_e	X_0^2	X_e^2
7	7	49	4	49
6	8	48	36	64
8	6	48	64	36
8	7	56	64	49
7	7	49	49	49
8	8	64	64	64
2	5	10	4	25
4	3	12	16	9
4	3	12	16	9
4	3	12	16	9
4	1	4	16	1
2	4	8	4	16

$\sum X_o = 64 \qquad \sum X_e = 62 \qquad \sum X_o X_e = 372 \quad \sum X_o^2 = 398 \ \sum x_e^2 = 380 \ \sum X_o X_e = 372$

Now, we have correlation coeff. Between X_o and X_e is

$$r = \frac{N \sum X_o X_e - \sum X_o \sum X_e}{\sqrt{N \sum X_0^2 - (\sum X_o)^2} \sqrt{N \sum X_e^2 - (\sum X_e)^2}} = 0.71$$

Hence, By using spearman brown prophecy formula, the reliability of full test is

$$\frac{2r}{1+r} = 0.83 \text{ (high correlation)}$$

Pre test of the students of experimental and control group

Required score change in descending order

S.N	Experimental Group		Control Group		$d_1 = \overline{x_1} - 29$	f_1d_1	$f_1d_1^2$	$d_2 = \overline{x_2} - 28$	f_2d_2	$f_2d_2^2$
	Score (X_1)	Freq. (F_1)	Score (X_2)	Freq. (F_2)						
1	35	2	34	2	6	12	72	6	12	72
2	34	2	33	2	5	10	50	5	10	50
3	33	3	32	3	4	12	48	4	12	48
4	32	2	31	2	3	6	18	3	6	18
5	31	2	30	2	2	4	8	2	4	8
6	30	2	29	2	1	2	2	1	2	2
7	28	3	28	2	-1	-2	3	0	0	0
8	25	1	27	1	-4	-4	16	-1	-1	1
9	24	1	25	2	-5	-10	25	-3	-6	18
10	20	1	20	1	-9	-9	81	-8	-8	64
11	18	1	17	1	-11	-11	121	-11	-11	121
		N=20		N=20						

Mean 29.7   Mean 28.85

Variance = 21.71   variance = 19.68

Standard deviation=4.66   Standard deviation = 4.44

Value of distribution (t) = 0.59

Value of F-distribution (f) = 1.103

Appendix VI

Post test result of students of experimental and control group

(require score arrange is descending order)

S.N.	Experimental group		Control group		$d_1 = \overline{x_1} - 38$	$f_1 d_1$	$f_1 d_1^2$	$d_2 = \overline{x_2} - 31$	$f_2 d_2$	$f_2 d_2^2$
	Score (X_1)	Freq. (F_1)	Score (X_2)	Freq. (F_2)						
1	47	1	40	1	9	9	81	9	9	81
2	46	2	39	1	8	16	128	8	8	64
3	45	1	37	2	7	7	49	6	12	72
4	44	2	36	2	6	12	72	5	10	50
5	43	2	35	1	5	10	50	4	4	16
6	42	1	34	2	4	4	16	3	6	18
7	39	2	33	2	1	2	2	2	4	8
8	37	2	32	1	-1	-2	2	1	1	1
9	36	1	30	2	-2	-2	4	-1	-2	2
10	34	2	28	1	-4	-8	32	-3	-3	9
11	33	1	26	1	-5	-5	25	-5	-5	25

12	31	2	12	2	-7		-14	98	-9		-18	162
13	23	1	20	2	-15		-15	225	-11		-22	242

Mean = 38.7   mean = 31.2

Variance = 38.71   Variance = 35.21

Standard deviation= 6.22   Standard deviation = 5.93

Value of students distribution (t) = 3.902

Value of F- distribution (f) = 1.099

Appendix VII

Statically formula used in data collection and analysis procedure.

S.N	Subject	Notion	Formula
1	Mean	$(\bar{X})$	$\dfrac{\sum fx}{N}$, where x= random variable F= frequency
2	Variable	S^2	$\dfrac{\sum fd^2}{N} - \left(\dfrac{\sum fd}{n}\right)^2$
3	Pooled variance	S_p^2	$\dfrac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$
4	Standard deviation	S	$\sqrt{\dfrac{\sum fd^2}{N} - \left(\dfrac{\sum fd}{N}\right)^2}$
5	Pearson's correlation coefficient	r_H	$\dfrac{N\sum xy - \sum x \sum y}{\sqrt{N\sum x^2 - (\sum x)^2}\sqrt{N\sum y^2 - (\sum y)^2}}$
6	Difficulty level of item	$(P\%)$	$\left(\dfrac{R_u + R_L}{N}\right) \times 100\%$
7	Discrimination index of item	D	$\left(\dfrac{R_U - R_L}{N/2}\right)$ where R_U = number of correct response given by upper 27% students, R_L = number of correct response given by lower 27% students, N= total students lie on 27 %
8	S. Brown split- half reliability of the test	r_H	$\dfrac{2r}{1+r}$

| 9 | t-Distribution | | $$\dfrac{\overline{X_1} - \overline{X_2}}{\sqrt{\dfrac{1}{N_1} + \dfrac{1}{N_2}}\sqrt{\dfrac{(n_1 - 1)S_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}}}$$

 Where $\overline{X_1}$ and $\overline{X_2}$ are mean score of experimental and control group respectively. S_1^2 and S_2^2 are the variance of experimental and control group respectively. |
| 10 | F- Distribution | F | $$\dfrac{S_1^2 (\text{large variance})}{S_2^2 (\text{small variance})}$$ |

Episode – 1

Properties of triangle. Objectives:- After completion of the lesson student will be able to.

→ Explain the properties of triangles

→ Do experimental verification of the property of triangle

→ Solve the problem related to triangle.

Activity I

The teacher will reminding about angle measurement by taking some question to the students. What is triangle? Do you have protractor? How do you measure the each angle of triangle? Then teacher will be drawn a piece (no.7) from the set of tangram
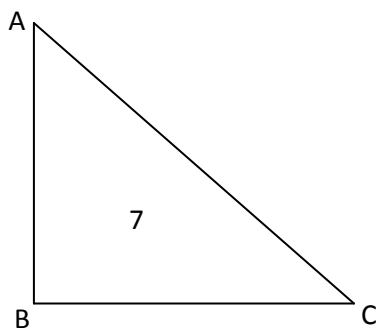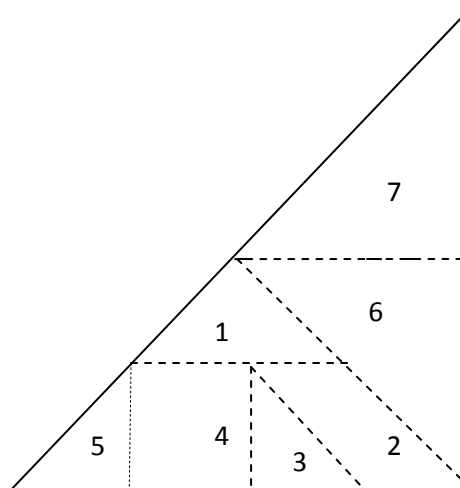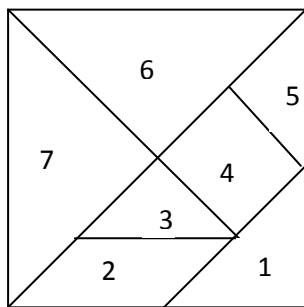
Angle	∠ABC	∠BAC	∠BCA	∠ABC+∠BAC+∠BCA
Measurement				

After measuring the each angle of ABC by using protractor every student will be got sum of each angle of a triangle is equal to 180^0. At least they will be conducted that the sum of interior angle of triangle is 180.

i.e $\angle ABC + \angle BAC + \angle BCA = 180^o$

Activity II

Teacher will be proved the sum of interior angles of every triangles is 180 by experiment with using tangrams teacher will be told to all students to take one place (no. 6) of tangram.
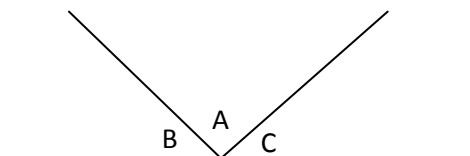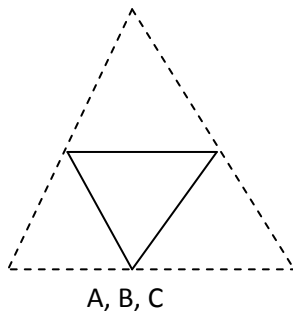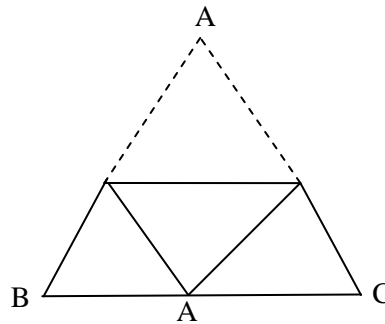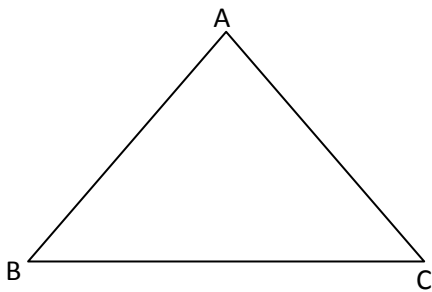
The teacher will also be doing such activity simultaneously with students. He will be told them to fold each corner of the ABC according to the above figure. By folding the hard paper the teacher will be demonstrated about the sum of three interior angle of ABC is 180^0 At last teacher will be given different shapes of triangles and ask them what is the result?

Activity III

After teaching the fact that the sum of interior angles of any triangles is 180^0 The teacher will be given an example as follows.
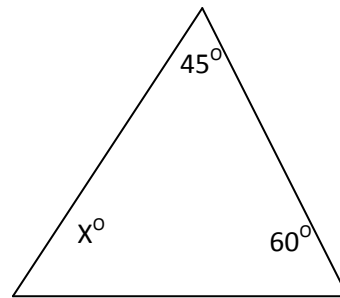
Solutions:

Step I: We know that,

$$X^o + 45^o + 60^o = 180^o \text{ [being sum of interior angle of } \triangle \text{ ABC]}$$

Step II: $x^o + 105^o = 180^o$

Or, $x^o = 75^o$

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Similarly the teacher will be given some problem to solve without using protractor.

i)

A x°   55° C
   45°
   B   A

ii)

56°
y   x°

iii)

x   y   C
55° B   45°

iv)

50°
x°   y°
115°
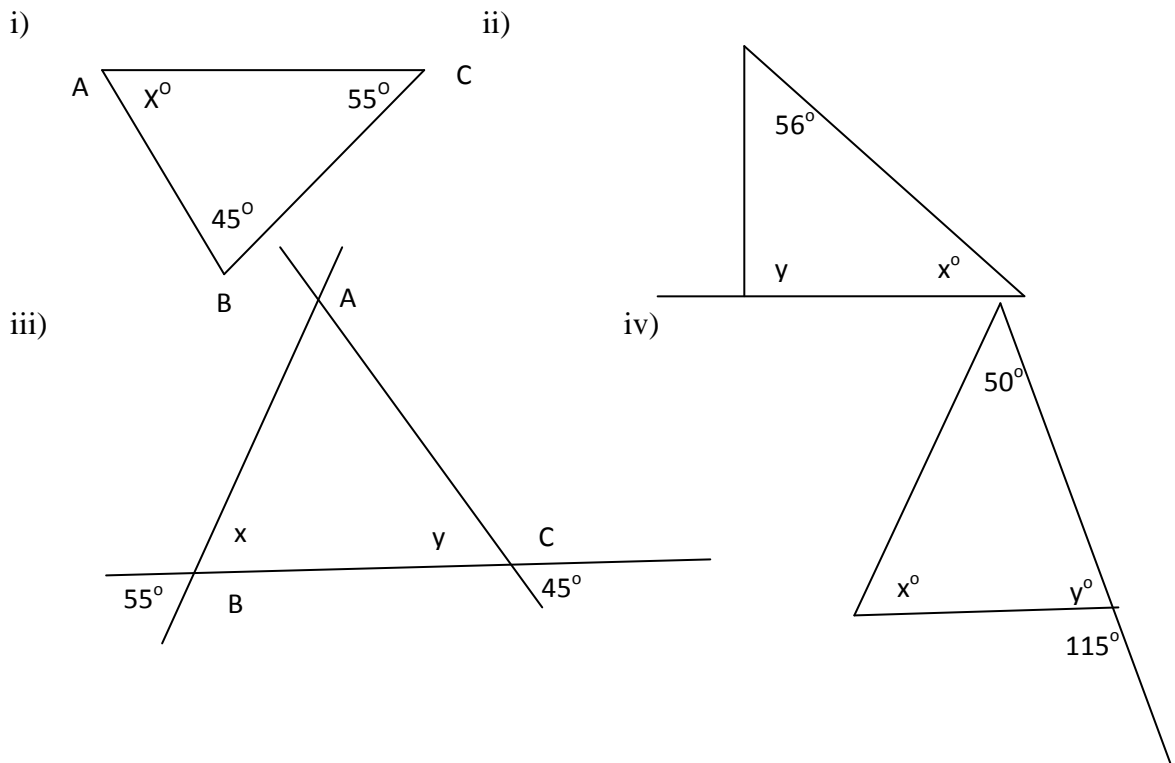
Activity IV: Experimental verification of the base angle of isosceles triangle are equal

→ To warm up students teacher will be asked some previous questions such as

- What are isosceles triangles?

- What do you mean by base angle of triangle?

Teacher will be taken three isosceles triangle and gives
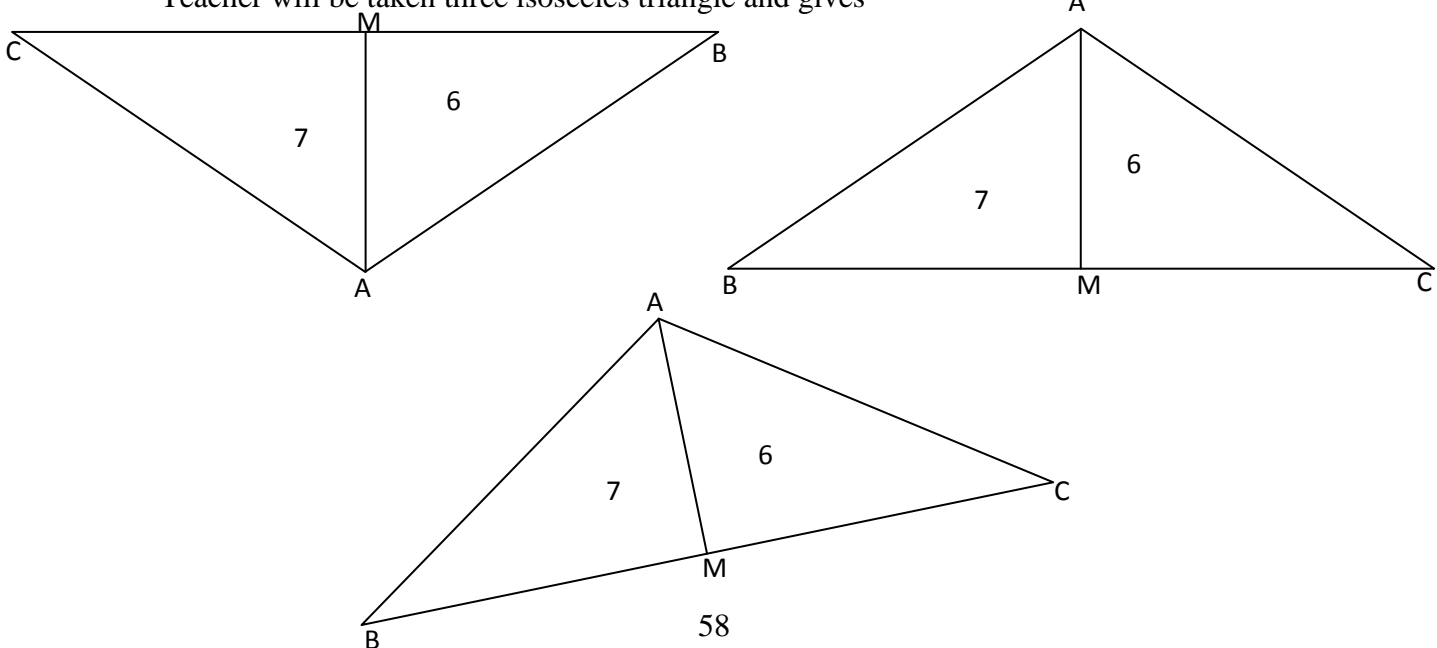
C   M   B
       6
   7
   A

A
   7   6
B   M   C

A
7   6
B   M   C
       58

He will be direct to the student's observation of this figure and take the ideas from the students.

The teacher will give to measure of all the angles of each triangle and tabulated the result.

Figure	Angle opposite to the equal sides		Remark
I	∠ABC	∠ACB	
			∠ABC= ∠ACB
II			∠ABC= ∠ACB
III			∠ABC= ∠ACB

Conclusion: The base angle of isosceles triangle are equal

Second method:

The teacher will be proved the base angle of isosceles triangle is equal by experiment using tangram. Teacher will be told to all students to take two piece (no.6 and 7) of tangram
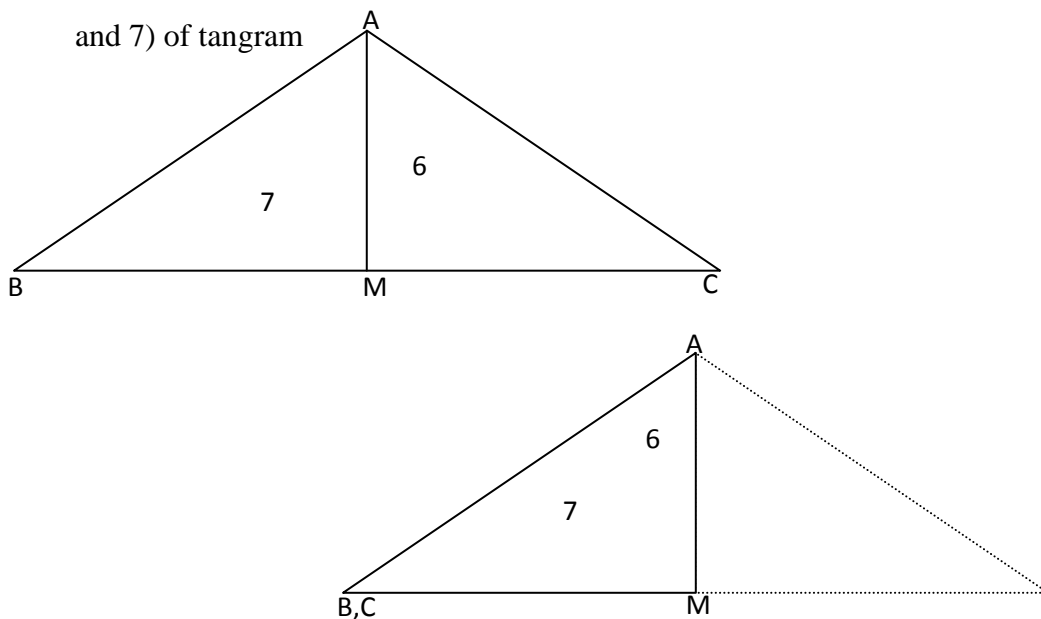
The teacher will also be doing such activities simultaneously with students. He will be told them to fold the triangle ABC according to the above figure. After that the teacher (discussing with students) will be demonstrated about the base angle of isosceles triangles are equal.

Activity V: Experimental verification of the vertical angle of isosceles triangle is perpendicular to the base and bisect the base

First of all, teacher will be drawn three isosceles triangles ABC of different sizes
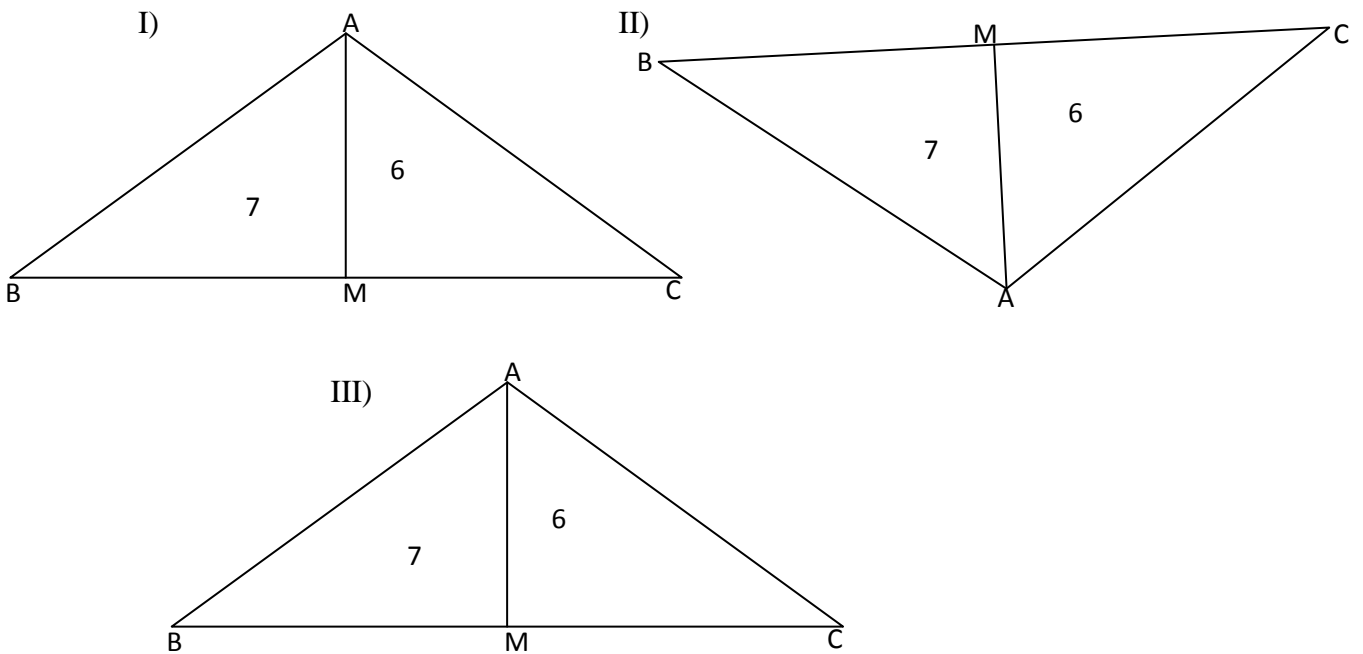
Where in each triangle ABC, draw AM, bisector of angle BAC meeting the opposite sides BC at M

Measure the side BM and CM the angle AMB and AMC in each of the triangle and tabulate the result

Fig.	BM	CM	Result	∠AMB	∠AMC	Result
I			BM=CM			∠AMB= ∠AMC AM ⊥ BC
II			BM=CM			∠AMB= ∠AMC AM ⊥ BC
III			BM=CM			∠AMB= ∠AMC AM ⊥ BC

Conclusion: The bisector of the vertical angle of isosceles triangle is perpendicular to

the base and bisect the base.

Second Method:

The teacher will be proved the bisector of the vertical angle of isosceles

triangle is perpendicular to base and bisect the base by experiment using tangram

teacher will be told to all students to take one piece (no.6) of tangram
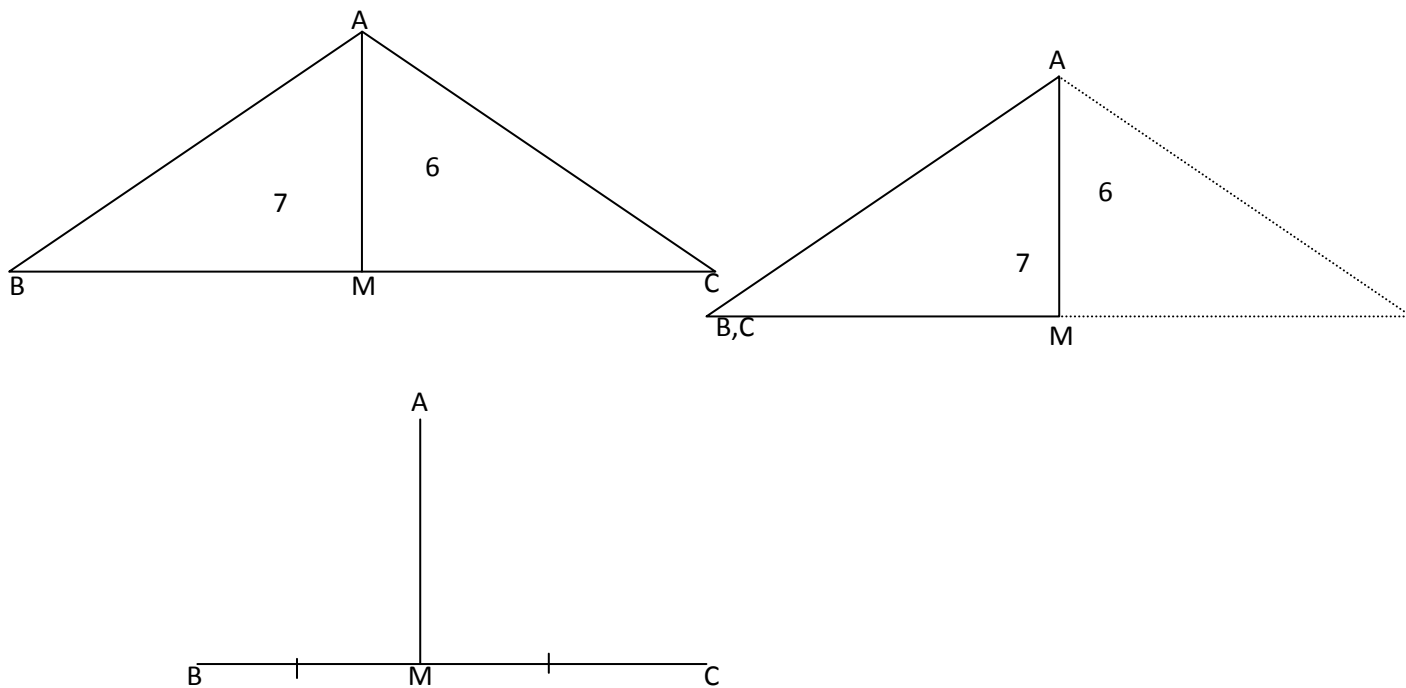
The teacher will also be doing such activities simultaneously with students. He will be told them to fold the ABC according to the above figure. By folding the hard paper teacher (discussing with students) will be demonstrated about the bisector of the vertical angle of an isosceles triangle is perpendicular to the base and bisect the base.

Activity VI

In the following figure find the value of unknown angles.
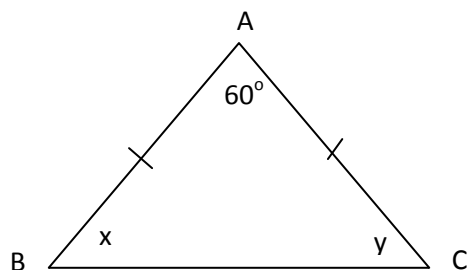
First of all teacher will find out what is given and what is to be found the question discussing with students.

Solution

Step I: $60^0+x^0+y^0= 180^0$ (being the sum of interior angle of a triangle)

Step II : $60+x+x = 180^0$ (x and y being base angle of isosceles triangle)

Or $60^0 +2x = 180^0$

$X= 60^0$ and $y = 60^0$

Similarly teacher will be given some problem for practice to the students from the exercise and discussion.

Episode II

Parallelogram

Exercise: After completion of this episode students will able to:

  I.   Explain properties of the parallelogram.

  II.   Do experimental verification of the properties of parallelogram.

  III.   Solve the problem related to the parallelogram.

Activity – I

$\rightarrow$ To worm up the students, teacher will asked them some previous question such that

- What is quadrilateral?

- What do you mean by parallel lines?

- Say about opposite sides, angles, diagonals of the quadrilateral?

Teacher will take place (no.2) from the set of tangram and given its name.
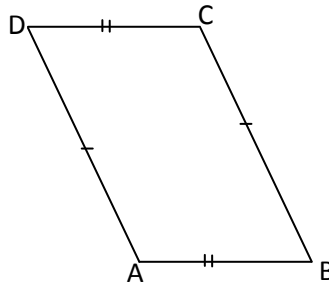
He will be direct to the students observation of this figure and take the ideas from the students.
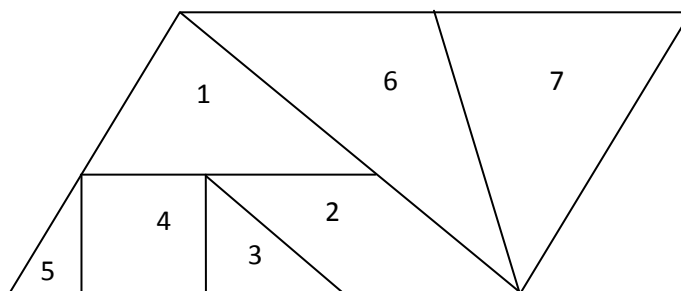
Then teacher will be explained about it.
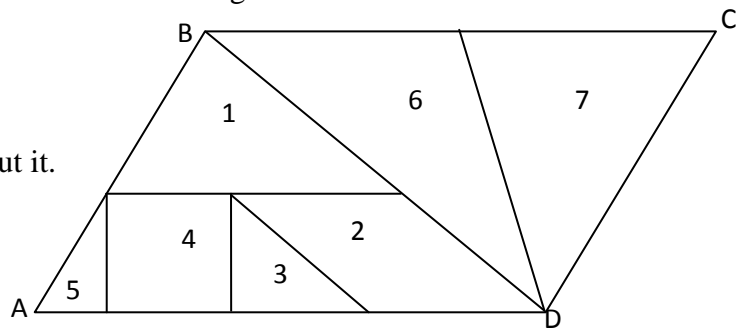
- Its opposite sides are equal and parallel.

- AB=CD and AB parallel CD, AD=BC and AD parallel BC.

- Its opposite angle are equal

- Its diagonals bisect each other.

    Diagonals AC and BD bisect each other at O.

Then teacher will show the figure which is combined from a set of tangram.

Teacher will be tried to match the condition of this figure with first figure by discussing with the students.

Finally teacher will be conducted that a quadrilateral can be a parallelogram, if it satisfies any of the following condition.

- If its two pair of opposite sides are parallel.

- If its two pair of opposite angle are equal.

- If it's any two opposite sides are equal and parallel.

- If its diagonal bisects each other.

Activity II

Experiment 1: Experimental verification of opposite side of parallelogram.

Step I: First of all, teacher will be drawn three parallelograms ABCD of different sizes with the help of a set of tangram
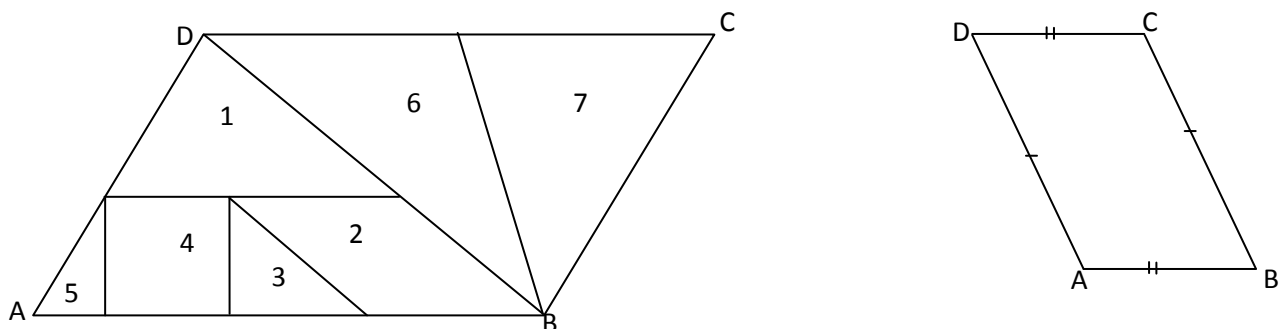
Step II: Teacher will be direct students to measure the sides of each parallelogram by helping of the rulerand write the measurement in the following table.

Figure	Length of the opposite side		Length of the opposite side		Result
	AB	CD	AD	BC	
I					AB= CD and AB = CD
II					AB=CD and AB = CD

Finally, teacher will be concluded that the opposite sides of parallelogram are equal.

Experiment 2: Experimental verification of opposite angle of parallelogram

Step I: Teacher will be drawn three parallelograms ABCD of different sizes with the help of a set of tangram.
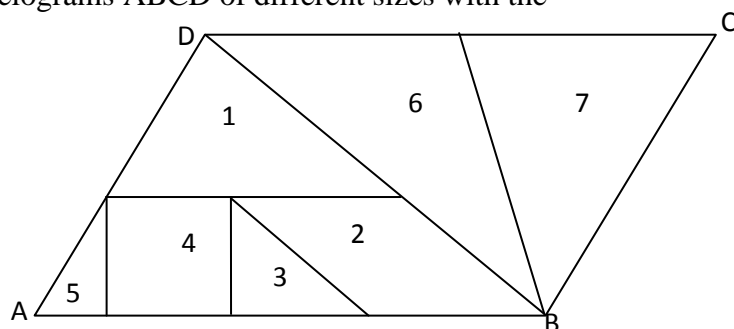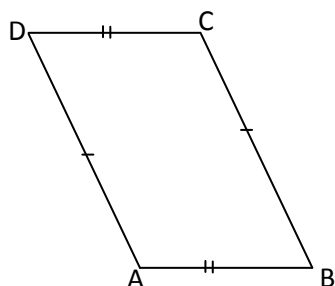

Step 2: Teacher will be said to students to measure the angle of parallelogram with the help of protector write, the measurement in to following table

Figure	Size of opposite angles		Size of opposite angles		Result
	∠A	∠C	∠B	∠D	
I					∠A = ∠C and ∠B = ∠D
II					∠A = ∠C and ∠B = ∠D

Finally teacher will be concluded that the opposite angles a parallelogram are equal

Activity III

I) In the following figure find the unknown size of angle.
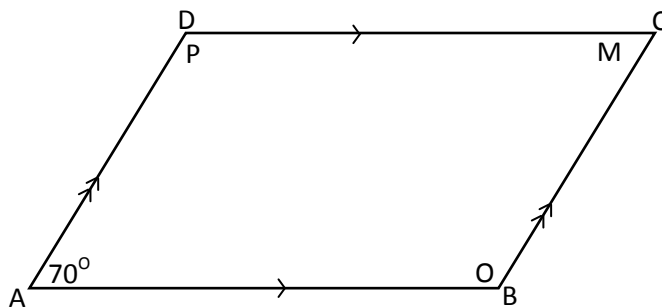
First of all teacher will be evaluated students pre requisite knowledge such as

- What is the sum of co-interior angle?

- What is the relation between opposite angle of a parallelogram?

Teacher will be awarded to students what is given and what is to be found?

Solution

Step I: M=70 (being opposite angle of a parallelogram)
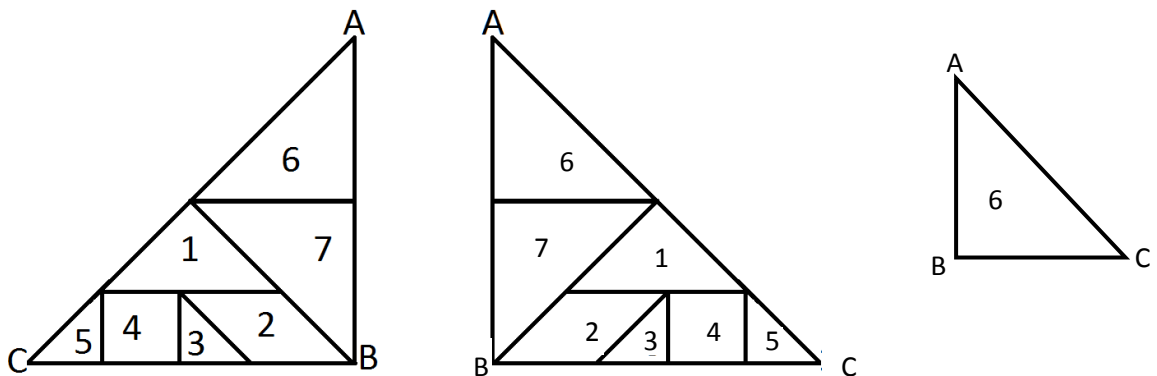
Step II: O+70 =180 (being the sum of co interior angle)

Or O= 110

Step III : O=P=110 (being opposite angle of a parallelogram)

For the practice teacher will give all the problem of exercise 15.1 as a homework

Activity IV: Experimental verification of the Pythagoras theorem

Step I: Teacher will be drawn three similar triangles ABC of different sizes with the help of tangram.

Step II: Teacher will be said to students to measure the length of each side of triangle with the help of ruler and write in the following table.

Figure	Side AB	AB^2	Side BC	BC^2	Side AC	AC^2	Result
I							$AB^2+BC^2=AC^2$
II							$AB^2+BC^2=AC^2$
III							$AB^2+BC^2=AC^2$

Finally teacher will be concluded that $h^2 = p^2+b^2$ in similar triangle.