

**THE EFFECT OF GROUP WORK PROBLEM SOLVING STRATEGY
ON STUDENTS' SKILL, ACHIEVEMENT AND ATTITUDE IN
MATHEMATICS CLASSROOM: IN DINKULA SECONDARY AND
PREPARATORY SCHOOL IN SOUTH NATION NATIONALITY
PEOPLE REGIONAL STATE, ETHIOPIA**

MSc THESIS

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JANUARY 2019

HARAMAYA UNIVERSITY, HARAMAYA

**The Effect of Group Work Problem Solving Strategy on Students' Skill,
Achievement and Attitude in Mathematics Classroom: In Dinkula
Secondary and Preparatory School in South Nation Nationality People
Regional State, Ethiopia**

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DEDICATION

I dedicate this thesis manuscript to my Mother Chalut Tirkaso and my father Misganu G/meskel for their support in the completion of this Thesis.

STATEMENT OF THE AUTHOR

By my signature bellow, I certify that this thesis is my own work and that all sources of materials used for this thesis have been acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at the Haramaya University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree or certificate. Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the Department of Mathematics or the Dean of the Postgraduate Program Directorate when in his or her judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author of the thesis.

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BIOGRAPHICAL SKETCH

The author was born on 22 July 1991 G.C in South Nation Nationality People Regional State at Gurage Zone Endegagn Woreda. He attended his elementary school from 1-8 at Mehal Endegagn school and his high school of Hadiya Zone Yekatit 25/67 and Preparatory school at Wachamo school , He then joined Ambo University in September 2001 E.C and graduated with B.Sc degree in Mathematics on July 17, 2011. Soon after graduation, he joined Haramaya University for postgraduate diploma in teaching and he joined Dinkula Secondary and Preparatory school in south nation nationality people regional State of Gurage zone Endegagn Woreda. In July 2014, he joined the postgraduate program directorate at Haramaya University to follow his MSc Degree in mathematics.

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ACRONYMS AND ABBREVIATIONS

EQAO	Education Quality and Accountability Office
ETP	Ethiopian Education and Training Police
FDRE	Federal Democratic Republic of Ethiopia
GW	Group Work
MAT	Mathematics Achievement Test
MOE	Ministry of Education
NCTM	The National Council of Teachers of Mathematics
PAT	Problem Achievement Test
PISA	Program for International Student Assessment
PSPT	Problem Solving Performance Test
PSSS	Problem Solving Strategy Scale
TGE	Transitional Government of Ethiopia

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ABSTRACT

The main purpose of this study was to analyze the effect of group work learning and problem solving strategy on student's skill, achievement and attitude towards mathematics. The study was conducted at Gurage Zone Mehale Endegagn Worda Dinkula secondary and Preparatory school. The study employed as a quasi-experimental study was carried out to address the research objective. From the total 262 Natural science students 112 students were selected to the study and equally divided into experimental group 56 students and control group 56 students. Two types of instruments were used for measurement. mathematics achievement test problem solving performance test, and in survey method using five likert scale questionnaires and observation check list were used to know students attitude towards problem solving strategy and group work learning, problem solving strategy scale and teachers' level of practice using problem solving strategy. Pre-test and post-test questions of achievement and problem solving performance test, problem solving strategy scale, group learning and problem solving strategy attitude questioners and observation check list were prepared as data collection tools. Pilot study was carried out on 35 students of the same background but not in the sample group to test the reliability of pre and post achievement tests and problem solving performance tests. The effect size and t-test were used to describe both group students' achievement and performance test scores and attitude. In which both groups were taught the same topic. The experimental group was taught the topics on topic vector and transformation of the plane through group work learning and problem solving strategy while comparison group was thought the content by traditional method .Results indicated that implementing problem solving strategy and group work learning improved experimental group students' academic achievement by 9.41% and their problem solving skills by 9.0% and 12.15% of attitude towards problem solving strategy and group work learning respectively. Students developed positive attitude towards group work learning and problem solving strategy and teacher level of practice applying to solve mathematics problem in mathematics classroom was satisfactory. Their academic achievement, problem solving skill and attitude toward mathematics were positively correlated and it was noted that of the two group whose successes were the same at the beginning, the experimental group students came out more successful than the control group. It can be inferred that problem solving strategy and group work learning technique increase the academic achievement, problem solving skill and students' attitude toward mathematics.

1. INTRODUCTION

1.1. Background of the Study

Education is a lifelong process by which knowledge, skill and attitude is acquired. It also helps people to live as a useful and acceptable member of the community (Farrant, 1964). According to Education and Training Policy of Ethiopia (ETPE, 1994); education empowers people to make all round participation in the development process by acquiring knowledge, skills and attitude of individual and society at large. Ethiopia Education and training policy (1994) also stated the main objective of educational system is to cultivate the individual capacity for problem-solving and adaptability to the environment by developing the necessary knowledge, ability and attitude.

Mathematics is the language of science to succeed in science students must use mathematics. Thus high quality science depends on high quality Mathematics. NCTM, (2002) Mathematics curriculum should include the continued development of language and symbolism to communicate mathematical ideas regarding the role of Education in the development of the individual and in wider sense of society. The Ethiopian Education and Training Policy (ETP) cited in Andulem (2006). For instance, has the following to stipulate. Education enables man to identify harmful traditions and replace them by useful ones. And it helps man to improve, change as well as develop and conserve his environment for the purpose of an all rounded development by diffusing science and technology in to the society (TGE, 1994 cited in Andulem , 2006).

Mathematics has developed into a very powerful science through many generations of experimentation and theory building. It is a science composed of well-founded expectations of how the natural world should behave and it then uses the tools of mathematics to describe these behaviors. According to the subject's content, science teaching methodology should provide a framework that student can learn science and prove their skill by solving problems since subjects in general; mathematics in particular can be taught through problem solving instructional approach. Problem solving strategy involves taking series actions in the process of an investigation that seeks to bridge the gap between the state of problem and anticipated goal(Jacson, 1975). It is not only finding the correct answers but also is an action, which covers a

wide range of mental understanding and ability. Group work learning is one of modern methods of teaching. It is the study for the same goal in small groups by helping each other, thus in group work learning, students are expected to help, discuss and argue with each other. Assess with each other's current knowledge and fill any gap in each other understandings. So, it is one of the parts of modern way of teaching that assist students to work together and help each other.

One of the most important targets of the modern education is to educate individuals to solve problems, easily which they encountered, education programs had the important ultimate purpose of teaching students to solve mathematical problems and advise developing the skill necessary to solve a wide range of problems. Effective teaching instruction helps students connect mathematics with how it affects their lives.

Traditional method of teaching is another way of teaching math. It usually comprises of a lecture that introduce concepts of the lesson either by demonstration or by deriving equations which describe the concept. Gallagher et al. (1999) stated that most of the question that teacher asks in conventional teaching are direct question and do not stimulate higher-order thinking. The teacher might also show the students how to solve few problems and occasionally suggest how to complete the mathematics cleverly. Finally, the student's knowledge of mathematics is tested by an examination composed of problems similar to those they have encountered while completing their homework.

In traditional instruction, student generally completes the course without gaining conceptual understanding or developing problem-solving skills. Recently, mathematics educators have begun to explore how to overcome those difficulties encountered through traditional method instruction. Most of their efforts have focused on improving students, conceptual understanding of mathematics and attitude towards mathematics.

According to Wasley (2006), Students who participate in collaborative learning and educational activities outside the classroom and who interact more with faculty members get better grades, are more satisfied with their education, and are more likely to remain in college A collaborative learning environment, as opposed to a passive learning environment, helps students learn more

actively and effectively (Murphy, Mahoney, Chen, Mendoza-Diaz and Yang, 2005). The idea that attitude toward mathematics is relevant in the teaching and learning process was shared by mathematics educators. Teachers and other mathematics educators generally believe that student learn more effective when they are interested in what they learn and that they were achieve better in mathematics if they like mathematics. Therefore, continual attention should be given towards creating, developing, maintaining and reinforcing positive attitudes. Student's attitudes and belief have an enormous impact on their performance in a particular subject area.

Thus, this study aims at examining the effect of group work learning and problem solving strategy on the students' skills to solve mathematics problems, academic achievement and attitude of the students towards with a special reference to topic vectors and transformation of the plane and teachers' level of practice problem solving strategy in Dinkula secondary and preparatory school. Thus study was performed by developing achievement and performance test such as mathematics achievement test, problem solving performance test, questionnaires and observation check list. MAT contain multiple-choice test with four alternative and PSPT was also workout type test .For the reason the researcher focused on the effect of group work problem solving strategy on students' skill, achievement and attitude in mathematics classroom.

1.2. Statement of the Problem

Problem solving instructional approach and its impact on learning science has been extensively not only affected by external factors (such as big class, shortage of teaching materials teachers job dissatisfaction etc) but also affected by internal factors that affect student problem solving skills, achievement, attitude and understanding of science concept because both of them have their own impact that impeded problem solving instructional approach in mathematics class.

Problem solving instructional approach includes group work learning and problem solving strategies, which help students to understand the concept of the lesson by working together in small group and make them active participant in instructional process.

In teaching learning process group work problem solving strategy is the essential aspect of understanding mathematics concepts since the interaction between a teacher and students and

among student themselves is regarded as a crucial element in mathematics learning and teaching process. Group work learning and problem solving strategies are part of modern method of teaching. The researcher has four years mathematics teaching experience in Dinkula secondary and preparatory school. During all these years, the researcher observed that almost all mathematics teachers use lecture method. However, currently, it is not widely used in our school system if we use them in our instructional methodology they might raise students' problem solving skills, achievement and attitude of students towards mathematics.

In traditional method teaching, students does not encourage actively participate in the teaching learning process. It can be observed from research result that teaching strategies that enhance student's performance and attitude towards mathematics such as group work learning had not been implemented. Instead the predominant method of teaching in Dinkula secondary and preparatory school was found to be traditional teacher-dominated class instruction methods.

In traditional method teaching, most of the questions that teachers ask are direct question and they do not stimulate higher-order thinking (Gallagher, 1997). It means it does not emphasize on deep conceptual understanding of the subject and problem solving skills. Thus, it is not effective for the majority students.

A numbers of researchers were conduct on practice of group work learning. For instance National Council of Teachers of Mathematics (2000) Problem Solving Standard states that high school math students should be able to "build new mathematical knowledge through problem solving; solve problems that arise in mathematics and elsewhere; apply and adapt a variety of appropriate strategies to solve problems; monitor and reflect on the process of mathematical problem solving" (NCTM, Problem Solving). According to the views of Leu(2000), to make the new Ethiopian training policy document practical, extensive changes have been made to reform the curriculum in different ladders of education. The shift in the new education curriculum emphasizes a change from rote, passive learning to a more active, learner focused education and the development of a higher order thinking skill as the basis of the teaching process MOE (2003).

The purpose of this study is to examine the effect of group work learning and problem solving strategy on student achievement, attitude and investigated teacher level of practice being used problem solving strategies in mathematics classroom in Dinkula secondary and preparatory school. Even though its advantage is mention in the above by the researcher it is not performed practically in one governmental Dinkula secondary and preparatory school. Thus the researchers focused on the effect of group work learning and problem solving strategy on students' problem solving skills, achievement and attitude on topic like vector and transformation of the plane. In addition to this there are no researchers that have been conducted especially the effect of group work problem solving strategy in students' skill , achievement and attitude in mathematics classroom in one Governmental Dinkula secondary and preparatory school.

1.3. Research Questions

This study attempts to answer these research questions:

1. Do group work learning and problem solving strategic methods have significant effect on students' achievement and problem solving skills in mathematics classroom?
2. Do group work learning and problem solving strategy have an effect on student attitudes toward mathematics classroom?
3. How often do teacher use problem solving strategies and group learning in their mathematics classroom?

1.4. Objectives of the Study

1.4.1. General objective

The general objective of this research is to investigate the effect of using group work learning and problem solving instructional strategy on students' academic achievement, problem solving skill and their attitude towards mathematics classroom and teachers' levels of practice using problem solving strategy in mathematics classroom.

1.4.2. Specific objectives

- To determine the effect of group work learning and problem solving strategy on students' achievement and problem solving skill
- To evaluate whether students' attitude towards mathematics will be changed when they are exposed to group work learning and problem solving strategy.
- To investigate teacher's level of practice in problem solving strategy in mathematics classroom.

1.5. Significance of the Study

The findings of this study would be significant to all the mathematics teachers and students, educational expert and researchers. It encourages their involvement in examine the effect of group work learning and problem solving strategies. It also encourage teachers to pick and choose this method of teaching in order to improve the strength of students' conceptual understanding of the subject and introduce the important of group work learning and problem solving strategies among students in solving problems, achievement and attitude towards mathematics subject. It is extremely important for the teacher to realize that the influences of their teaching method on student academic performance and achievement. Learners can benefit when teachers realize their students' attitude and when they provide opportunity for student to develop positive attitude. It may contribute certain ideas for stakeholders and relevant decision makers and it may also serve as a base for researchers who attempt to study problem related to this. Moreover, the result of this research is important to Dinkula secondary and preparatory school and to the Woreda Educational Bureau .Finally, it may pave the way for school further investigation for those who might be interested in similar issues

1.6. Scope of the Study

The scope of this study was limited to one secondary and preparatory school of Gurage Zone of Endegagn Woreda. The main focus of this study was to find out the effect of problem solving strategy and group work learning on students' achievement and attitude that is encountered at Dinkula secondary and Preparatory school. It is also investigate students' attitude towards problem solving strategy and group work learning, which help them to improve their

achievement and attitude toward mathematics classroom. The study emphasized on only grade eleven natural science students at Dinkula secondary and Preparatory school. This study is the topic of vector and transformation of the plane.

1.7. Limitation of the Study

Due to the shortage of time and resource, it was limited to Dinkula secondary and preparatory school. This might also limit what the researcher wanted to know about effect of problem solving strategy and group work learning on student's achievement, problem solving skill and attitude. Some of the students reply questions in the questionnaires in wrong way, as they were not aware of what it means.

1.8. Operational Definitions of key Terms

Significant terms that the researcher used throughout this study are as follows:

Achievement: is a measure the amount of academic content a student learns in a determined amount of time

Attitude: is a positive or negative emotional disposition towards Mathematics.

Group Work : is defined as small groups of learners discussing together as a team to

Preparatory school : is A school designed to prepare students for higher education. In Ethiopia today it commonly consists of Grades 11 and 12 (MoE, 2008).

Problem solving: is the process of working through details of a problem to reach a solution or systematic operations and individual's critical thinking skills.

Skills: is acute logical thinking and problem solving abilities.

1.9. Organization of the Study

This study organized in to seven chapters. Chapter 1 presents the introduction including background, statement of the problem, research questions, objectives, significance, scope and limitations of the study and operational terms. In chapter 2, relevant literature on the effect of group work problem solving strategy on students' skill, attitude and achievement was cited. Chapter 3 provides adscription of the study area and background of the respondent. It also

displayed research design, data collection methods and sampling, materials and methods needed to conduct the study. In chapter 4 results obtained from the research and discussion of the analysis is presented. Chapter 5 provides summary, conclusions and recommendations based on the findings of the study. Chapter 6 listed all the references used in the study. The last chapter 7, revealed appendices which includes all questions used to gather necessary data from respondents

2. REVIEW OF RELATED LITERATURE

2.1. The Notions of Group Work

Group work, working in small groups or collaborative working as it is often referred is basically a group of between two and six students formed to discuss a particular issue or perform a particular task. For clarification, it includes the terms cooperative learning, collective learning, peer learning, reciprocal learning, or team learning. Whichever construction is used, the reference is to learning that involves students in working with others and, crucially, learning together on a foundation of student-student interaction (Biggs and Tang, 2007), together with the concept of learning from each other (Race, 2007). Group work is used to achieve a range of teaching and learning goals

2.2. Effectives of Group Work

The goal of group work for both the teacher and students should be to gain and build knowledge together. Solving problems in groups involves each person in the group contributing and listening to each other. Even if their ideas may not be “correct”, group members should still reflect on these ideas together. Everyone must understand the work being done and come together to agree on the problem through good discussion while working on it (Webel 2013). Students and teachers have only slightly different ideas about the characteristics of effective group. They generally agree that effective group work involves collaboration and sharing mathematical ideas and understandings where students are helping and supporting each other rather than the teacher doing so. They both also believed that cooperative group work should be a good opportunity for social interactions and active participation. Students put slightly more emphasis on the social aspect of group work when describing it. They think it is effective when the group members like each other, are able to help each other, and when the problem or task is completed by the group. Teachers on the other hand, seem to focus the idea of effective group work more on the mathematical task aspect.

They think it is effective if the task covers the mathematical curriculum thoroughly (Mulryan 1994). There are certain aims or focuses involved with solving the mathematical problem at hand and when reached, make the group work effective. Solving problems is said to be the whole group's responsibility. It emphasizes certain behaviors from students such as resolving disagreements, collecting ideas, and wanting to be convinced of mathematical ideas and claims. Effective group work does not mean that the only things students are doing is getting and giving help. If some students are getting help by seeking out the so called experts in their group who are giving them the help or doing all the work, this is not productive (Webel 2013). Separating group members with certain labels such as help getters and help givers takes away from the effectiveness of working together as a whole for full mathematical understanding.

Group work has become increasingly important in higher education, largely as a result of the greater emphasis on skills, employability and lifelong learning. Davis (1993) identifies three types of group work: Informal groups that are composed of ad hoc clusters of students who work in class to discuss an issue or test understanding. Formal groups are established to complete a specific task in a single or several class sessions over many weeks, (e.g., project work, library or research tasks, progress reports, laboratory experiments, presentations, debates, field studies, musical performances). The work of a formal group may or may not be assessed. Study groups or teams that are specifically formed to provide support for members; usually for the duration of a course. These guidelines deal mainly with the second type of group (i.e., the establishment, process and assessment of formal learning groups).

2.3. The Purpose of Using Group Work in Classroom

Group learning is about people working together in carefully designed learning environments. A clear rationale for assigning group work is to be found in Race (2007) who offers a practical and academic framework of the processes and issues arising. He argues that the human species has evolved on the basis of group learning, Learning from others is the most instinctive and natural of all the learning contexts that we experience' (Race, 2007). Research shows that well-constructed group work with a clear rationale and conviction of the value of the process leads to a greater retention and understanding of what is taught (Boud, Cohen and Sampson, 1999; Millis

and Cottell, 1998). To ensure that group work is both well designed and conducted, a number of universities have developed some sound and detailed guidelines in this area (e.g., University of Technology Sydney, University of Western Australia, University of Texas (US), Oxford Brookes (UK) and our own Victoria Business School). Graduate employability is increasingly emphasized by the Government and the TEC, with New Zealand employers seeking multi-skilled graduates with strong interpersonal, communication and social skills. Other highly valued attributes include problem solving, evaluation, and teamwork. These qualities are recognized in graduate program attributes and course objectives. Carefully planned group work provides an opportunity for students to develop and nurture these important skills and attributes

2.4. Advantage of Group Work

Group work can benefit the learner in the following ways it encourages questioning, discussion and debate and can advance motivation to learn by raising interest levels and Students get to know each other and develop working relationships, which can have wider and lasting benefits it engages students as active participants and gives them opportunities of learning by doing. They are put in situations where they have to communicate and explain what they are doing, why they are doing it and take account of the views of others also it safeguards against students being isolated and hence serves as a valuable retention strategy. Students have an opportunity to work with others whose learning experiences may be different to their own. In forming a group ethos there is an emphasis on how you learn as well as what you learn. It develops students' transferable skills of collaboration, team-working, negotiation, listening, organization, leadership and evaluation, which students can take into their working lives. It enhances student satisfaction of their learning experience and can nurture and promote self-esteem. It can stimulate creative ideas through brainstorming, engaging in discussion and through debate of different perspectives on the approach to a particular task. Group work provides a platform to nurture independent and lifelong learning. Students can gain confidence, become more aware of their strengths and are encouraged to develop their own ideas. Group work can allow students to undertake a wider variety of assignments. Work done in groups can often simulate the tasks students might do in 'real world' situations People remember group discussions better. Group learning fosters learning and comprehension. Students working in small groups have a tendency to learn more of

what is taught and retain it longer than when the same material is presented in other instructional formats (Cross and Major, 2005; Davis, 1993) Team work is highly valued by employers.

2.5. Disadvantage of Group Work

Disadvantages: Although working in groups has its advantages, there are also times when problems arise four disadvantages. The first one there may be pressure from the group to conform to the majority opinion. Most people do not like conflict and attempt to avoid it when possible. By readily acquiescing to the majority opinion, the individual may agree to a bad solution just to avoid conflict. The second one an individual may dominate the discussion. This leads to members not gaining satisfaction from the group because they feel too alienated in the decision making process. The third one some members may rely too heavily on others to do the work. This is one of the most salient problems that face groups. Some members do not pitch in and help and do not adequately contribute to the group (Freeman and Greenacre, 2011). One solution to this problem is to make every group member aware of the goals and objectives of the group and assign specific tasks or responsibilities to each member and the fourth it takes more time to work in a group than to work alone. It takes longer to accomplish tasks when working with others. However, the time spent taking and analyzing problems usually results in better solutions. Overall, effective student participation in group work is an important learning outcome for higher education courses (Elgort, Smith and Toland, 2008). Although many students feel as though they can accomplish assignments better by themselves rather than in a group, instructors find that group work helps the students apply knowledge (Elgort, Smith and Toland, 2008). However, merely assigning a group does not itself create critical thinking outcomes. Therefore, the instructor must be cognizant of how best to facilitate effective collaborative learning environments. There are four stages of group work. First, the instructor must decide that he/she wants to incorporate group work into the class. The group work should be designed into the syllabus. The second stage involves teaching the students to work in a group. Instructors cannot assume that students know how to work together, structure time, and delegate tasks. The instructor must be able to teach the students how to work proactively in groups. This leads to the third stage, which involves monitoring the groups. The last stage, and the most important to the

students, is the assessment of the group. The instructor must develop a concrete rubric for grading the students

2.6. Teacher's Role in Group Work

The teachers do to ensure that the group work occurring in their classroom is effective it has been found that a process help teacher intervention can be slightly more effective in mathematics classrooms. Process help interventions focus more on the classroom norms dealing with interaction in group works rather than how the students are reasoning about the problem. In other words, with this type of intervention, teachers are not trying to improve the students' problem solving process, but rather their interaction process. The process help intervention is most successful when a teacher sets up the problem with the class as a whole before breaking up the students into their groups. It is important to make sure the students understand the context of the problem and what is expected of them (Dekker and Elshout-Mohr 2004). Setting expectations about student interactions can act as a road map for group conversations. However, these expectations are not meant to be strict rules but rather just a structure for their interaction so students know what is expected of them when working together in groups (De Jarnette, Dao and Gonzalez 2014). If the set up is done well, then teachers should not have to interfere much with the students as they work together in their groups (Dekker and Elshout-Mohr 2004). Later on, discuss strategies that students can use to make group work effective.

However, the majority of students would not be able to come up with and incorporate these strategies themselves. Therefore, it is the teacher's responsibility to model discussion strategies that students can use before; during and after students does their group work. Teachers can also make clear the good strategies already being used by pointing them out when they occur during group work. This helps students recognize when they ask good questions that will help make their group work and discussions effective. This is important for teachers to do since students may not realize they are doing so (DeJarnette, Dao and Gonzalez 2014). It is important for teachers to know their students well enough to be sure that group work will be effective if used in their classrooms. In most cases effective group work will be easiest to implement and more worthwhile with higher achieving students.

Research has found that when compared to lower achieving students, higher achieving students tend to have a better grasp of what characteristics are involved in making group work effective. They have a more complex understanding of what it takes to make group work cooperative, which makes group work more beneficial for them (Mulryan 1994). Therefore, if a teacher thinks it is possible that their students may not be mature enough to understand group work goals and expectations, it is the teacher's responsibility to realize if and how often group work should be implemented in their classroom

2.7. Student's Role in Group Work

In Group Work What should students do to ensure that the mathematics work they are doing together in their groups is effective It believe that students have to be open minded to group work, especially if it is something they are not familiar with. Through practice of working with others on more complex or open ended tasks, they will hopefully develop into productive group members. There are also three strategies that students have been observed using to maintain productive mathematical discussions in their groups: asking questions about the problem, sharing the mathematical authority within the group, and challenging one another's mathematical ideas (DeJarnette, Dao, and Gonzalez 2014). It is also partly the teacher's responsibility to teach these strategies to their students so that the group will have these resources for working more effectively together.

Although it may seem that students will always ask each other questions about the problem when put into groups, this is not usually the case. If always exposed to a more traditional classroom setting, students are used to the teacher asking them questions and have not had the responsibility of questioning themselves. If students can learn to ask each other questions about the content of the problem or the process used for problem solving, this is one strategy for effective group work. Doing so leads to dialogue and discussion amongst the members of the group and they will be other to see each other's understanding. It is key, however, to stress the importance that questions and discussions within a group should try to include everyone as evenly as possible in order to be effective (DeJarnette, Dao, and Gonzalez 2014).

A second possible strategy students can take part in to make group work productive is sharing the mathematical authority within their group. Sharing authority can be very challenging for groups because in doing so, students should take turns asking and answering questions and take turns presenting parts of the solution to the problem. More often than not, students are likely to accept that one or two group members have the authority usually these are the students that have found the answer to the problem or better understand the task (DeJarnette, Dao, and Gonzalez 2014). However, if the authority can be shared somewhat evenly, this allows for all the students to have an active role in the group and contribute toward the solution and mathematical understanding.

The last strategy students can use to try to make group work more effective is challenging each other's solutions and strategies. Students should push each other to explain or justify their solutions rather than just immediately accepting the ideas their group members are giving. This will challenge all the members of the group to develop a more sophisticated solution and make their mathematical argument more explicit. Like the previous strategy, challenging each other is not used as commonly amongst students as some other strategies are. Getting students to use this strategy though can make group work much more effective because it pushes students to develop better solutions and reasoning that benefits the entire group (DeJarnette, Dao, and Gonzalez 2014).

2.8. The Process of Forming Groups

The best place to start group work (much like anything else) is at the beginning. When developing a course syllabus, the instructor can determine what topics and theme lend themselves to group work. This is the time that instructors can think about how they will form their groups, help negotiate the group process, and decide how to evaluate the final product. Johnson, Johnson and Smith (1991) suggest that group tasks should be integral to the course objectives. This means that the group work should complement the learning objectives outlined in the syllabus. If one of the learning objectives is to promote critical thinking skills or writing enhancement, then the group work should support these areas

2.8.1. Group Size

The dynamics of group size is an important component of group work. A small group is often considered to consist of three or more people (Beebe and Masterson, 2003). Groups of two are called dyads and are not encouraged for group work because there are not a sufficient number of individuals to generate creativity and a diversity of ideas (Csernica et al., 2002). In general, it is suggested that groups of four or five members tend to work best (Davis, 1993). However, Csernica et al. (2002) suggests that three or four members are more appropriate. Larger groups decrease each members opportunity to participate and often results in some members not actively contributing to the group. In situations where there is a shorter amount of time available to complete a group task, such as an in class collaborative learning exercise, it is suggested that smaller groups are more appropriate. The shorter amount of time available, the smaller the group should be (Cooper, 1990; Johnson, Johnson and Smith, 1991). Group work can be especially beneficial for large classes. Wright and Lawson (2005) found that group work helped students feel that the class was smaller and encouraged them to come to class more often. The felt more invested in the course and in the class material, which promoted active learning in a large class environment

2.8.2. Selection of Group Member

Assigning the members of the group is integral to the success of the group. Some faculty members prefer to randomly assign students to groups. This has the advantage of maximizing heterogeneity of the group (Davis, 1993) and is an effective way of assigning group member in large classrooms. If the class size is small and the instructor is familiar with most of the students, the instructor can select the group members based on known attributes of the class. For example, the instructor can form the groups while taking to account performance levels, academic strengths and weaknesses, ethnicity, and gender (Connery, 1988). Additionally, some instructors allow the class the self-select their group; however, this has some disadvantages. Self selected groups often gravitate toward friends and roommates (Csernica et al., 2002). This can result in the students self segregating and spending more time socializing than working on the group

project (Cooper, 1990). Research suggests that groups which are assigned by the instructor tend to perform better than self selected groups (Felder and Brent, 2001).

2.9. Attitude

Attitude is defined as a way of thinking or feeling about something. When working with students, their attitude can play an important role in the learning process. If a student feels that he or she can do well and be successful, then he or she usually is successful. However, if a student feels that he or she cannot do the required work, then he or she may not be willing to put forth the effort needed to be successful. Cooperative learning can be a useful tool to help develop a positive attitude toward learning. In the study by Bernero (2000), those students who struggled with math continued to struggle and became frustrated with individual work, but improved both academically and in self-confidence (thus leading to social improvement), when it came to group work. Students working cooperatively often enjoy the experience and believe that their classmates like them. This belief that they are accepted by others also allows the students to believe that they are more successful academically.

This perception of success increases students' self-esteem (Walmsley, 2003). Cooperative learning has been linked to other positive social or affective outcomes. One benefit is the increase in social skills of students who participate in group work (Whicker et al., 1997).

These skills can help students perform in situations outside of the school setting. Being able to work with others can be a very useful attribute to have when seeking employment in many companies. It is important to create an atmosphere in the classroom where students feel comfortable to share their ideas. This may take time for the group members to become aware of the strengths that each member can bring to the entire group. Structure of the groups is important. In the research by Gillies (2004) and Yamarik (2007), children in the structured groups demonstrated less non-cooperative behaviors and less off-task behaviors than their peers in the unstructured groups. They were more willing to work with others on the task, listen to what they had to say, and share ideas and information (Gillies, 2004). The novelty of working in small groups sparked a greater interest in the material (Yamarik, 2007)

2.10. Achievement

Achievement is a measure the amount of academic content a student learns in a determined amount of time how achievement tests differentiated from other types of test. Probably the answer from our experience could be that achievement test measure what a person has learned. This is obviously true but reflection will show that all tests measure what an individual has learned. We may take another direction and say that achievement test assess mastery of academic subject, yet the written test that are given to obtain a driving license of an achievement test. That is if attest designed to evaluate teaching it is an achievement test. However there are instance where achievement test are used primarily to predict frequently the best predictor of future performance (Brown,et al.,1983)

2.11. Factor Affecting Group Work Problem Solving Strategy

Learner problem solving strategy and measuring interaction with peers and teachers in online environments can enhance learning outcomes. Researchers expressed that Group Work learning affects perceived positively learning, quality assessment of assignments, achievement, and satisfaction and retention rates in the literature (Hrastinski, 2008). For example, Woods (2002) stated that both quality and quantity of interaction with the instructor and peers are much more crucial to the success of online courses and student satisfaction than to success and satisfaction in traditional courses. Davies and Graff (2005) examined the relationship between the level of online participation and student grades (i.e. high, medium, low, fail). They concluded that students achieving high or medium passing grades engaged more actively than students achieving low passing grades and also students achieving low passing grades were more active than students who failed in the several modules of courses even though greater online interaction did not lead to significantly higher performance. Another study was conducted to analyze discussions in courses delivered completely online by Picciano (2002) who found that students perceived greater quality and quantity of learning as a result of participating in the discussions.

In the literature, there are several studies that take an interest in factors affecting the participation in online asynchronous discussion. Cheung and Hew (2008) discussed factors that

are fallen into three different categories: attributes of the asynchronous online discussion, role of the facilitator and design of discussion activities. Similarly, Vonderwell and Zachariah (2005) searched for factors that influence learner participation and they found that online learner participation are influenced by technology and interface characteristics, content area experience, student roles and instructional tasks, and information overload. In another study conducted by Vrasidas and McIsaac (1999) who examined the nature of interaction in an online course from both teacher and student perspectives and they concluded that the structure of course, class size, feedback, and prior knowledge of computer mediated communication all affected the interaction.

Moreover, there are other important aspects that influence student's participation and one of them is related to the differences in students' demographics and abilities in online courses. For example, Godwin, Thorpe and Richardson (2008) mentioned that students taking online courses with a high level of interaction tended to be different from the students taking the courses with a low level of interaction in regard to age, gender and previous qualifications. Although the results were not statistically significant, high interactive students were generally younger, male and having had higher educational qualifications. McLean and Morrison (2000) analyzed the relationships between learner participation and six socio demographic variables (i.e. sex, age, education level, occupation, residence in urban or rural areas, and region of residence) and they found two variables (holding a university degree and living in an urban area) , to be the strongest predictors of participation.

Another study by Prinsen, Volman, and Terwel (2007) examined the influence of learner characteristics on degree and type of participation in a CSCL environment. Caspi et al. (2006) mentioned that CMC media such as synchronous courses, but, participation in the web-based instructional environment tends to be lower while comparing to participation in the face-to-face courses. There are several factors affecting learner participation that was mentioned in online environments. There have still not been enough findings to answer general questions about these factors, especially impact of student characteristics in online discussion due to continuously variations in CMC applications, methods of study, instructions, roles of teachers and students (Prinsen, Volman and Terwel, 2007). As a result, the relationship between participation and

interaction and learning outcomes is a complex phenomenon and we need more studies related to this phenomenon (Picciano, 2002).

2.12. Strategies to Foster Participation in Group Work Learning

There are many to participate in class. Equitable class participation does not necessarily mean that all students are expected to participate in the same way. Student engagement in class is greatly influenced by expectation that is tractors set for class room behavior teaching strategies that are employed and ways student interaction are structured during class strategies to set the stage for more equitable class participate include the following. Through these steps instructors help align students expectations with instructor intention to ensure that all students recognize their presence class is valued and their contributions to the class.

2.13. Summary

Participate actively in mathematical activity and discussion, freely exchanging ideas and Problem solving strategies with their classmates, teachers, taking intellectual risks and defending positions without fear of being incorrect, Students should be actively involved in the learning of mathematics. Although some students absorb mathematics through teacher presentations, all students learn better when they are actively engaged in the learning process. Students need to be active participants in their mathematics classes, discussing mathematics with the teacher and with each other, engaged in activities which enhance their learning. They need to be prepared to propose strategies for solving problems, to provide explanations for why things work as they do, and to make conjectures for the consideration of their classmates. In order for them to do this, they must have a supportive classroom environment which encourages diversity of thought, Teachers should establish this supportive classroom environment by making mathematical discussions a daily activity, Encouraging students to make suggestions and conjectures, and to propose strategies and explanations, conveying to all students that they must all listen to their classmates respectfully .

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Description of the Study Area

The study area was carried in one governmental school, namely Dinkula secondary and preparatory school which is located in south nation nationality people of regional state in Gurage Zone Endegan Woreda specifically in Dinkula town. Dinkula is a town in eastern part of Welkite city. It is around 222 km far from Addis Ababa, 70 km from Welkite city and 506 km from Hawasa city. **Welkite** is a town which is the administrative center of the Gurage Zone of the Southern Nations, Nationalities and Peoples' Region (SNNPR), this town has a latitude and longitude of $8^{\circ}17'N$ $37^{\circ}47'E$ and an elevation between 1910 and 1935 meters above sea level.

3.2. Research design

This study employs both experimental and descriptive survey to assess the effect of problem solving strategy and group work learning on student's problem solving skill, achievement and attitude toward mathematics and mathematics teachers leave of practices applying problem solving strategy in mathematics class by developing mathematics achievement test. Problem solving performance test, questionnaires and observation checklist.

This study consisted of experimental and control groups. The experimental group was treated with the program and exposed to group work learning and problem solving strategy using selected topics by themselves, with the researcher acting as a guide, giving hint and facilitator. The control group was taught the same topic by using conventional methods; both groups were taught by researcher only out of the regular class time.

The research design for study was per-test (achievement and problem solving performance test) and post-test (achievement test and problem solving performance test). A pre-test, post-test, and attitude scale were used for both experimental and control groups. Group learning and problem solving strategy attitude questionnaires were applied only to the experimental group. Finally, immediately after content time completed, post-test was given to both groups.

The researcher developed pre-test to test the group knowledge level and post- test to measure statistical difference between both groups.

3.3. Source of the data

In order to gather relevant information a reliable and primary data source were used. The main sources of the data were grade 11th natural science students, Nine mathematics teachers, per achievement test, problem solving performance test, post achievement test and post-problem solving performance test, attitude scale on problem solving performance test, experimental group attitude scale on group work learning and problem solving strategy and teacher level of practice on group work learning and problem solving strategy.

3.4. Population and Samples

The participant of the study was 9 mathematics teachers who are thought Dinkula secondary and preparatory school and students of grade 11 natural science students was the target of the respondents and they were divided in two groups based on their pre-test score results and the experimental group (56) students and a control group (56) students

3.4.1. Sampling technique

The population of the study comprises a total of 262 grade 11 natural science students' enrolled to the school during the 2017/18 academic year. Accordingly, from the total number of 262 grades eleven natural science students' 112 students were selected as the sample for this study. The classes were used as strata to determine the sample that would be taken from each class. The individual respondents from each class were taken using EPSEM(equal probability of selection method) since it usually reach self-weight sample in which the simple arithmetic mean obtained from the sample data is an unbiased estimate of population mean.

$$n^k = \frac{N^k}{N} n \quad (\text{Ababayehu, etal.})$$

Where n^k : sample size for kth strata

N^k : Population size of the kth strata

N: total population size, n: total sample size

Table 1. Sample of student taken from each class.

Section	Number of student	Number of sample student
A	65	27
B	66	28
C	65	28
D	66	29
Total	262	112

3.5. Treatment

The duration of the study to cover the selected topics was both experimental and control groups received the same instruction for sixty (60) minute throughout four- week periods based on the lesson plan in the Appendix XXI. Four class periods were planned per week for each group. For this study, some topics such as introduction of vectors and operation on vectors, specific facts about vectors, principles and theorems about vectors in problems involving vectors an transformation of the plane. Both experimental and control group were taught the selected topics by the researcher.

3.5.1. Conventional learning task covered

Teacher centered method of teaching were based up on lessons employing lecture method to the concept of selected topics. Teaching strategies depend upon teacher's explanations, discussion, solve the problem and work sheet administered and done by the teacher for each class. The teacher treated the entire class as a unit, wrote notes on the blackboard about the definition of different terminology and a more holistic approach which focuses on individual students' needs and self-controls. After teacher's explanation, the concept were discussed, summarized and state again the main point of the lesson. The method of the communication in the classroom was from teacher to students. In convention method teaching and learning instruction, the teacher is the dispenser of the knowledge.

3.5.2. Group work learning task covered

In experimental group , before the treatment 14 groups were formed each group contain four students in a group to facilitate group work learning activates and the group variation was considered in the study based on their academic knowledge, different learning styles and academic performance based on their pre-test results . Then, students were trained on how to apply problem solving strategy to solve mathematics problems and group work learning for two days by showing samples questions before the treatment. Every member of the group had some responsibilities. Students were supposed to participate actively in the group discussion. They had to share their knowledge, express their ideas and experience with other while working out a solution to the problem.

During the group work learning sessions, the teacher organized the groups and created a purposeful and group work atmosphere. When guidance was needed, the teacher asked open-ended questions, and gave plentiful opportunity for students to focus on the goal. The teacher encouraged students to develop critical thinking.

At the end each activity, students evaluate each other with respect to participation, preparation, interpersonal skills and the contribution of the program as a group and individual progress. In this way, it was expected that students would become aware of the roles and benefit of group work learning and problem solving strategy. The experiment group lasted four weeks. After which post –test where administered for both groups

3.6. Data Collection Instruments

In this study four instrument were developed to assess students' academic achievements, problem solving skill, attitude towards mathematics, group work learning and teachers' level of practice using problem solving strategy activities in mathematics classroom. These are mathematics classroom achievement test, problem solving performance test, problem solving strategy scale and attitude questionnaire and observation check list.

3.6.1. Mathematics achievements test (MAT)

This is a test, which is going to be developed by the researcher and group of mathematics teachers working in the school. For simplicity, the item would be multiple-choice test with four alternatives. The contents were taken from grade eleven unit eight mathematics text books and related reference books.

3.6.2. Problem solving performance test (PSPT)

A workout type test which included word problem prepared by group of teachers to assess students' problem solving skills and students problem solving performance questions to assess student problem solving skills. The test is developed in grade 11th unit eight mathematics text books and related reference.

3.6.3. Problem solving strategy scale (PSSS)

The item attached in (appendix XVII) would be used as the instrument to assess the students problem solving skill of mathematics the scale contained likert type item that provide information on students frequency of strategy use always , frequently , Sometimes ,Rarely, Never. Rating range from a high score of 5(always) to low score of 1 (never) with respect to frequency of strategy.

3.6.4. Classroom observation

For the classroom observation, checklist was prepared based on the expected teacher activities to solve mathematics problems in the classroom. Checklist prepared by the researcher together with mathematics department teachers solve mathematics problems, what is his/her steps, how often he/she uses problem solving strategies , does he/her apply problem solving strategy steps? Etc. the classroom observation has taken each successive class in all sample class, such way that researcher can be observed how class teachers can be observed how classroom teacher solve the mathematics problems in classroom strategy and in the classroom and the classroom observation was taken in successive classes in all sample class.

3.6.4. Attitude scale

In order to determine student's interest for group work learning and problem solving strategy, mathematics attitude questionnaires were developed by the researcher for only experimental group students. It consists of 15 items and free comment, and each comment was linked to five point liker scale ranging from SA=strongly agree, A=agree, N=Neutral, D=Disagree and SD=Strongly Disagree. The minimum score for an item is 1, and its maximum value is 5. The items in the scale were numbered as 5, 4, 3, 2, and 1 ranging from strongly agree to strongly disagree.

3.7. Data Collection Procedures

During experimental process, the students both group did work sheet and collect their result to analyze the progress of their problem solving skills and achievement. After experiment process finished both group filled the problem solving performance scale and experimental group only filled group work learning and problem solving attitudinal questioner and then both group took post-test (i.e. problem solving performance test and the achievement test).

The experimental group: Before starting teaching the content, the researcher divide the experimental group students in to 14 groups each containing 4 members and the group members remained the same until research data collecting time was completed. Students in their respective groups discussed on the given questions and problems, they asked each other the meaning and how they could solve the given problems. The researcher was facilitated learning , organized the learning contents for each period rather than being source of solution in the program and encouraged experimental group students towards thinking and reasoning through the given activities and problems. Students were organized in groups of 14 to carry out initial analysis of the problem, with guidance in the process but with no content knowledge instruction from the researcher they were instructed to ask each other how they got the answer to the given problems activities. Finally, the group was showed and reported their findings and solutions, communicated information as required by the problem with conclusion to the researcher.

The control group: The control groups were taught the same content with traditional lecture method by the researcher only. In this case the researcher prepared notes and definition of the

some mathematics terms and come to the class and explained, discussed, solved different problems and finally this groups was given summary note.

Data were collected through the data gathering tools stated above. Firstly experimental process the students in both group student did work sheet and collect this result to analyze the progress of this problem solving skill and achievement after experimental process both groups fill filled the problem solving performance scale and experimental group only fill group work learning and problem solving attitude questioners and finally both groups took post-tests

3.8. Methods of Data Analysis

The collected data from the problem mathematics achievement test(MAT) , problem solving performance test(PSPT), attitudinal questionnaires and problem solving strategy scale(PSSS) were analyzed by descriptive statistics such as mean (M), standard deviation(SD) and t-test an were employed. The mean gains of achievement scores which were treated under the comparison and experimental groups were compared and the significance of the mean and mean difference between the two groups was checked by using SPSS. The data from students pre-test and post – test of both groups were organized, analyzed and interpreted using statistical package for social sciences (SPSS). Finally, the result of the interpretation was discussed, summarized and concluded to give recommendations.

3.8.1. Pilot study of achievements test

Pilot test were carried out 35 non sample students to establish the reliability of the test that have the same background to the treatment groups. Pilot group reliability result of pre-achievement test items of 20 multiple-choice questions the cronbach's Alpha is 0.729. This value points out that a good reliability for the achievement test. Since, the accepted value of cronbach alpha is greater than or equal to 0.65. Pilot group reliability result of post achievement test items of 20 item of multiple-choice questions the Cronbach's alpha is 0.748. Thus the internal consistence of the test was found fit with acceptable cronbach's alpha value of greater than or equal to 0.65, This value indicates as well reliability for the achievement test.

3.8.2. Pilot study of group work problem solving performance

To determine the reliability of problem solving performance test item pilot –test was carried out on 35 Students with the same back ground with the treatment groups. Pilot group reliability result of pre-test problem solving performance items; the cronbach’s alpha of 10 items of work out questions is 0.7814. The internal consistence of test was found to be satisfactory. This value points out a good reliability for the problem solving performance test since suitable value of cronbach alpha is greater than or equal to 0.65.

Pilot group reliability result of post problem solving performance test items; a cronbach’s alpha value of problem solving performance post- test is 0.792 this value is a good reliability for the problem solving performance test since the advisable value of cronbach’s alpha is greater than or equal to 0.65

3.8.3. Effect size calculation

Effect size is simply a way of quantifying the size of the difference between two groups. According to Cohen (1988) an effect size indicated that two groups have significant difference or not an effect size result 0.5 described as medium and is larger enough to be visible below 0.5 is small and above 0.5 is large therefore the effect size (η^2) very small two groups equivalent and effect size above 0.5 it indicated two groups have significant

$$\text{effect size} = \frac{[\text{mean of experimental group} - \text{mean of control group}]}{\text{standerd deviation}}$$

$$SD_{\text{pooled}} = \sqrt{\frac{(N_E - 1)SD_E^2 + (N_C - 1)SD_C^2}{N_E - N_C - 2}}$$

3.9. Ethical Considerations

There are a variety of ethical issues that must be taken into consideration. Many of these involve negotiating the relationships between people involved in a given study. Research participants

should not be subjected to harm in any ways what so ever. Respect for the dignity of research participants should be prioritized. Full consent should be obtained from the participants prior to the study. The protection of the privacy of research participants has to be ensured. Adequate level of confidentiality of the research data should be ensured. Anonymity of individuals in the research has to be ensured. Any deception or exaggeration about the aims and objectives of the research must be avoided. Affiliations in any forms, sources of funding, as well as any possible conflicts of interests have to be declared. Any type of communication in relation to the research should be done with honesty and transparency. Any type of misleading information, as well as representation of primary data findings in a biased way must be avoided and Voluntary participation of respondents in the research is important.

4. RESULTS AND DISCUSSION

In this section the result obtained from the experiments, and the result of the students in the pre-test, post- test, response to questionnaires, interest and motivation difference between experimental and comparison groups of study based on the research hypothesis and objectives were analyzed and interpreted.

4.1. Background Information of Respondents

Population of this study were grade 11 natural science students and Mathematics teachers

Table 2. Background information of students

Age	Number of sample students					
	Experimental group			Control group		
	M	F	T	M	F	T
15-22	44	12	56	45	11	56

M=male, F=female, T= total

Table describes the total number of experimental and comparison group students. It also includes their gender distribution and age range.

Background information of teachers; all teachers are male and age 25 to 38 years, their qualifications are 3 BEd in mathematics teachers and 6 teachers are BSc in mathematics and their service years between 3 to 13 years

4.1.1. Mean scores results of pre and post test academic achievement of experimental and control group

As indicates in appendixes I and II, the academic mean score of experimental group students were 51.17, before the implementation of the program and 60.58, after the implementation of the program. This shows experimental group students improved their academic achievement score after the implementation of group work learning and problems solving strategy. However, as pointed out in appendixes V and VI, Pre -test means score of academic achievement test of control group students was 52.41, and that of the post achievement result

was 53.42, result of control group students also showed slight increment in average score of achievement.

Table 3. Two tailed paired samples t-test to determine the existence of significant difference in pre-achievement result between experimental and control groups

Group	Test	N	X	t_{cal}	Sig.(2tailed)	t_{cri}
EG	Pre-test	56	51.17	6.167	0.00	2.045
	Post-test	56	60.58			
	Gain		9.41			
CG	Pre-test	56	52.41	0.88	0.378	2.045
	Post-test	56	53.42			
	Gain		1.01			

Significant at the level of 0.05

The significance value for t for unrelated samples have equal variance assumed when the variances of the two sets of scores are approximately equal and equal variances not assumed when the two variances are quite different. T-value mean in statistics to find evidence of a significant difference between population and measure the size of the difference relative to the variation in the sample data and Two pared-sample t-test in the mean value: mean difference between scores in the two conditions, the second observation is dependent upon the first since they come from the same person.

The conclusion about statistically significant difference between post and pre-test mean score of experimental group students was made by comparing the (t_{cal}) value with the (t_{cri}) value. In the table above, calculated ($t_{cal}=6.167$) was greater than critical t-value ($t_{cri}=2.045$) for experimental group. Thus, there is significant difference in academic achievement of experimental group students before and after the treatment. This shows that the academic achievement of the experimental group students was significantly improved after the treatment than their achievement before the treatment. However, for control group calculated t-value ($t=0.88$) was less than critical t-value ($t=2.045$). This shows that control group students' improvement is not significant.

There is a small increment mean score of control group students compared to experimental group students. This shows that group work learning method of instruction is better than conventional method of teaching.

Table 4. Independent sample t-test to determine the significant difference between experimental and control groups achievement test mean score

	Group	N	Mean	T	Sig.(2tailed)	t _{cri}
Pre-test	Experimental	56	51.17	-0.503	0.616	1.671
	Control	56	52.41			
	Mean gain		1.24			
Post-test	Experimental	56	60.08	2.518	0.013	1.671
	Control	56	53.42			
	Mean gain		6.66			

Independent t test mean the single observation from each participant from independent groups, the observation from the second group is independent from the first since they come from different sample and comparing the difference between two means to distribution of differences between mean score. Table show that the mean score of the pre-test and post-test achievement for the control and experimental groups. There were no significant differences on the pre-achievement test mean scores, since the calculated t-value ($t=-0.503$) was less than the critical t-value ($t=1.671$) it was assumed that the two groups started out with equivalent means. Independent t-test samples were carried out to test whether the experimental and control groups differed significantly on the post achievement test.

As it was indicated in the table difference was observed between experimental and control group academic achievement mean score after the treatment. Since, the calculated t-value ($t=2.518$) exceeded t-critical value ($t=1.671$). This indicates that the academic achievement of the experimental group was improved than control group.

This finding validates the results of some earlier studies (Johnson & Johnson, 2005; Tanel and Erol, 2008; Moore, 2008; Sahin, 2010) which indicate that group work learning promotes greater long-term achievement than individual learning at least 24 hours after the treatment

The results of this study are consistent with the findings of the studies (Slavin, 2011; Sahin, 2010; Johnson and Johnson, 2008; Tanel and Erol, 2008; Webb, 2008; Moore, 2008) that indicate that cooperative learning results in greater long-term achievement than the traditional lecture-based teaching group.

4.1.2. Effect size calculation of achievement test

Effect size is on the whole a way of quantifying the size of the difference between two groups. According to Choen(1988) an effect size of 0.5 described as a medium and is large enough to be visible , below 0.5 is small and above 0.5 is large. The small effect size indicate that two group have no significant difference. Before the treatment or implementation of the program of group work learning and problem solving strategy the Effect size of experimental and control group approximately equal to zero (i.e Effect size=-0.384). Therefore, the effect size (η^2) before the treatment is zero. This show the two groups were equivalent before the treatment (50%) control group (50%) to experimental group. Effect size of experimental and control groups after the implementation of the program was 0.545. It indicated that the average person in the experimental group would score higher than control group that was initially equivalent.

4.2. Pre and Post Test Results in Problem Solving Performance

Problem solving strategy help students to analyze the concept of mathematics in detail relates the problem solving strategy to general problem solving method and introduce themselves to real word problem. The result obtained from the post problem solving performance test, problem solving activity on translation, Rotation and reflection of the plane showed that problem solving activity carried out in the experimental groups improved the students' problem solving skills. Students who were taught by implementing problem solving strategies were to try solving problems, were eager to rise to solving challenging problems and developed their problem solving skills.

When students have knowledge about problem solving strategy at the stage of problem solving it has been proven that students in experimental groups would have to solve mathematics problems sequence by sequence using knowledge and the problem solving

method students are able to interpret and understand the terms facts and mathematics concept based on their acquired knowledge. At the stage of problem solving, it has been demonstrated that the students in the experimental groups were able to combine the different pieces of interpreted information into a coherent structure in order to plan a solution.

4.2.1. Pre and Post Test Results in Problem Solving Performance

As indicated in appendixes III and VII, pre problem solving performance mean score of experimental group student before the treatment was 47.43 and control group was 48.22. This shows that experimental and control group mean score before the implementation of the program were almost the same. However, the performance mean scores of experimental group improved after the treatment i.e. mean score of experimental group after the treatment was 56.43 and control group was 49.67 as indicated in Appendixes IV and VII.

Table 5. Two tailed paired samples t- test to determine the significant difference of problem solving skills experimental and control groups

Group	Tests	N	Mean	t_{cal}	Sig.(2tailed)	t_{cri}
EG	Pre-test	56	47.43	5.754	0.00	2.045
	Post-test	56	56.43			
	Gain		9.00			
CG	Pre-test		48.22	0.879	0.383	2.045
	Post-test		49.67			
	Gain		1.45			

At significant at the level of 0.05 is a t-value is the relative error difference in context to the null hypothesis. The table shows that, calculated t- value ($t=5.754$) which was greater than critical t- value ($t=2.045$) for experimental group. Thus, there is a significant difference in problem solving skill of experimental group students before and after the treatment. This shows that problem solving skill of the experimental group student was significantly improved after the treatment. However, for control group student the calculated t-value ($t=0.879$) which was less than critical t-value ($t=2.045$). This shows that control group students upgrading was not significant.

Table 6. Independent sample t-test to determine the difference between experimental and control groups of problem solving performance test mean scores.

Pre- test	Group	N	Mean	T	Sig.(2tailed)	t _{cri}
	Experimental	56	47.43	0.483	0.412	1.671
	Control	56	48.22			
	Mean difference		0.79			
Post-test	Experimental	56	56.43	2.137	0.129	1.671
	Control	56	49.67			
	Mean difference		6.76			

The table above shows that problem solving skill of experimental and control group students before the treatments were approximately scored the same result since calculated t-value (0.483) less than t-critical value (1.671). The significant difference was observed between the two groups after the treatment. Since, the calculated t- value (2.137) exceeded t-critical value (1.671). This indicates that problem solving performance (skill) of the experimental group was improved than the control group.

4.2.2. Effect size calculation problem solving performance test

Effect size is simply a way of quantifying the size difference between two groups. Therefore, the effect size (η^2) of problem solving performance test result of experimental and control group before the implementation of group work learning and problem solving strategy was - 0.108 and this shows that the two groups before the treatment of the program were equivalent. An effect size the implementation program after the treatment is 0.56. This indicates that the average person in the experimental group would score higher than the control group that was initially equivalent.

4.3. Group Work Learning and Problem Solving Strategy Attitude scale for Experimental Group

Table 7. Response for the attitude questionnaire.

No	Questionnaire statement	SA	A	U	DA	SDA
		%	%	%	%	%
1.	My work is better organized when I work in a group	21.42	25	10.71	25	17.85
2.	Group work problem solving strategies helped me to understand the topic more	62.5	21.42	5.35	10.71	0
3.	Group work problem solving strategies encourage to exchange knowledge, information and experience	71.42	10.71	3.57	12.5	1.78
4.	Group work problem solving strategies made problem solving easier	60.71	17.85	7.14	10.71	3.57
5.	Group work learning creates relaxed classroom	50	19.64	3.57	21.42	5.35
6.	Group work learning and problem solving strategy allowed me to apply my knowledge to solve problems	58.92	28.57	0	10.71	1.78
7.	Group work learning create interaction with other student	73.21	14.28	8.9	0	3.57
8.	Group work problem solving strategy enables me to use others ideas together with my own	48.21	25	14.28	12.5	0
9.	Group work learning and problem solving strategies help weaker students in group	78.57	14.28	1.78	3.57	1.78
10.	Group work learning and problem solving strategies create good performance to solve mathematics problems	32.14	41.07	0	19.64	7.14
11.	Group work problem solving strategy Students actively Participate in the teaching and learning process.	39.28	14.28	14.28	14.28	16.07
12.	Difficult to work problem solving in groups because we spend much time talking about other things	17.5	17.5	5.35	32.5	26.78
13.	Group work Problem solving strategy steps waste time to solve mathematics problems	66.07	30.35	0	1.78	1.78
14.	The group work learning should be continued	62.5	23.21	5.35	8.9	0
15.	Maximum group size should be 4	32.1	32.1	1.78	12.5	21.4

N.B: SA=strongly agree, A=Agree, U= Undecided, D= Disagree , SD=strongly disagree

In the table above, item1, the students were asked whether their work where better organized when they are group. Thus while 12(21.42%) of the total respondent strongly agreed, about 14 (25%) of the respondents agreed, about 6 (10.71%) of the respondents Undecided, 14(25%) of

the respondents disagreed and 10(17.25%) of the respondents strongly disagreed that the learners are better organize their ideas when they work in group work problem solving strategy. This indicates that around 46.42% of the respondents said that their work is better organized when they are in group work problem solving strategy. From the observation, we can also realize that students who are voluntary engaged in a group work problem solving strategy can have better organized ideas to exchange their experience and share their knowledge with their friends. In addition, 42.25% of the respondents disagreed that their work is better organized when they are in group work learning and problem solving strategy. Generally the majority of 46.42% of the respondent agreed that their work could be better organized when they were in group work learning and problem solving strategy.

In item 2, about 35(62.5%) of them respondent strongly agreed, about 12 (21.42%) of the respondent agreed, about 3(5.35%) of the respondent Undecided and 6(10.7) of the respondent disagreed that the students are group work problem solving strategies helped me to understand the topic more. This indicates that 83.92% of the respondent explained that their agreement by the statement that the group work problem solving strategies helped me to understand the topic more in contrast to the above about 10.71% of the respondent replied disagreement. Since the group member solve the problem by bringing different ideas therefore group work problem solving strategies helped to understand the topic more.

As it is revealed on table item 3 about 40(71.42%) of the respondent strongly agree , about 6(10.71%) of them agree 2(3.57%) of them Undecided , 7(12.5%) of the respondent disagreed and 1(1.78%) strongly disagreed about group work problem solving strategies encourage to exchange knowledge, information and experience. the response of students confirms that they are activity encourage to exchange knowledge information and experience in group work learning and problem solving strategies because about 82.13% agreed to the above claim so the result clearly indicates that learners are actively seeking encourage to exchange knowledge, information and experience with their group members.

According to the table item 4, about 34(60.71) of the respondents explained their agreement strongly, about 10(17.85) of the respondents agreed, about 6(10.71%) of the participants disagreed and 2(3.57%) of the respondent strongly disagreed, that they like to work in group

because they can get group work problem solving strategies made problem solving easier. This contributed by engaging them to share the idea of the students 44(78.56%). However, about 8(14.28%) of the respondents explained their disagreement to do in groups because group work problem solving strategies made problem solving easier this indicates that some students did not support problem solving easier some of the students actively work problem solving in the groups. From this, one can conclude that some of the students need to get mark easily without effort and some of the learners need also to discuss with the group to solve the problem actively.

Item5, also indicated the suitability of the group work learning and problem solving strategy on group work learning creates a relaxed classroom about 28(50%) of the respondents strongly agreed and 11(19.64%) of them agreed this indicated that about 39(69.64%) of the respondent agreed with the suitability of the classroom arrangement and interaction for group work problem solving activities and to carry out different interaction and about 12(21.42%) of them disagreed and 3(5.57%) of the respondent strongly disagreed this implies that 15(26.99%) of the respondent disagreed with group work learning creates relaxed classroom no give suitable to work in group in the classroom. Generally the classroom arrangement and interactions was conducive to carry out actively group work learning and problem solving strategy in the classroom.

Regarding on group work learning and problem solving strategy allowed to apply my knowledge to solve problem on students item 6, shows that 33(58.92) students strongly agreed and 16 (28.7%) of the respondent agreed and about 4(10.71%) of the respondent disagreed and 2(3.35%) of the respondent strongly disagreed. All most 49(86.99%) of the respondent where agreed with that group work learning and problem solving strategy contributes for the learners feeling comfortable to apply the knowledge to solve mathematics problem and problem solving actively in the actively in group work learning and problem solving. This indicates that in group work learning and problem solving strategy allowed to apply knowledge to solve problem solving in the social status among the learners is obvious and very high and it perhaps creates social interaction to solve the problem between students especially those poor students helps to create problem solving actively so that they likely create themselves from learning and solving problem in group works freely and actively.

Item 7, also should that how far (to what extent) they organize their learner in group work learning creates interaction with other students and learn from each other, about 41(73.21%) reported strongly agreed, about 8(14.28%) reported agreed, about 5(8.9%) reported as Undecided and 2(3.57%) of them strongly disagreed. Thus 49(87.49%) of them agreed and 2(3.57%) of them are not agreed the group work learning create interaction with students with each other students actively solving the problem in the classroom is greater than the disagreement of the students. This indicates that the opportunity and chance give to the learner to solve the problem freely interact to each other and to arrive on agreement and generalization tasks they performed.

Item 8, about 27 (48.21%) of the respondents strongly agreed, 14(25%) respondents agreed about 7(12.5%) of the respondent where disagreed and 8(14.8%) of the participants where neutral that group work problem solving strategy enables to use other ideas together with their own. From this, about 41(73.21%) of the respondents explained their agreement and about 7(12.5%) of the respondent explained their disagreed by the statement that group work learning and problem solving strategy enables the students to use other ideas together with their own. This indicates that most of the respondent agreed by the statement of group work problem solving enables them to use the other ideas together with their own knowledge to bring one central point and correct solution related to the task which is given by their teacher from this one can concluded that sharing knowledge, exchanging of experiences and different ideas and the agreement were also reported the whole class

On item 9 shows that 44(78.57%) strongly agreed, 8(14.28%) of the respondent agreed, 2(3.57%) respondent disagreed and 1(1.78%) strongly disagreed by the statement group work learning and problem solving strategies helps for weaker students in a groups to get chance to ask or answer questions and clarifications during group work learning and problem solving strategies help weaker students in a group during learning progression, and about 52(92.85%) of the respondent agreed by group work learning and problem solving strategies help weaker students in a group from the result one can judge that group work learning and problem solving strategies help weaker students in a group solve a problem to get chance to ask questions for clarifications and respond to the question raised to their group members where

as more chances that it provided to solve the problem and they get opportunities to interact with one another and their group members.

According to the table item10, about 18(32.14%) of the respondents replied their a agreement strongly and 23 (41.07%) of the respondents also explained their agreement that they have group work learning and problem solving strategies creating good performance to solve mathematics problems, about 11(19.64%)of the participants explained their disagreement and about 4(7.14%) of the respondents replied strongly disagreed that cannot enjoy in the group work learning and problem solving strategy create good performance to solve mathematics problem in classroom. From this we can indicate that most of the respondents claimed there is enjoy in group work learning and problem solving strategies create good performance to solve mathematics problem in the classroom and can exchange experience, share knowledge and reflect ideas and feelings.

Item 11, shows that how much participants where devoted and committed to group work problem solving strategies, students actively participate in teaching and learning process in mathematics classroom. According to the question raised, respondents was whether the group work problem solving strategy students actively participate in teaching and learning process about 22(39.28%) of them strongly agreed and 8(14.28%) of them agreed on the group work problem solving strategies. Students actively participate in teaching and learning process, about 8(14.28%) of them disagreed and 9(16.07%) of them strongly disagreed. Almost 30(53.56%) of them agreed on group work problem solving strategies. Students actively participate in teaching and learning process in mathematics classroom

Item 12 about 10(17.5%) of the respondent strongly agreed, 10(17.5%) of the respondents agreed, about 18(32.5%) of the respondent explained their disagreement and about 15(26.78%) of the respondent replied their disagreement strongly that the difficult to work problem solving in groups because students spend much time talking about other things. From the given above data, about 20(35%) of the participant agreed by the statement they discount to work problem solving in group because students spent much time talking about other things. In addition, the majority of the respondent or about 33(58.83%) of the participants disagreed by the statement according to this data, most of the student simple to engage in the

group work problem solving and the much time did to solve the problem during group work in generally, the majority of the students disagreed about the idea. This indicates that student easy to work problem solving in group concluded the task and should use their time properly to complete the given task.

According to the above table item 13, about 37(66.07%) of the respondent replied their agreement strongly, 17(30.35%) of the respondent also explained their agreement, about 1(1.78%) of the participants explained their disagreement and 1(1.78%) of the respondent replied strongly disagreed that they group work problem solving strategies steps waste time to solve the problems in the group. From this data about 54(96.42%) of the respondents agreed by the statement group work problem solving strategies waste time to solve mathematics problems, from this indicates that almost all students of the respondent claimed that group work problem solving strategies waste time to solve mathematics problem to complete the task from the information we conclude that group work problem solving strategies steps waste time to solve mathematics problems.

Item 14, shows that about 35(62.5%) students strongly agreed, 13 (23.21%) students agreed, and about 5(8.9%) of the participant disagreed on group work learning and problem solving should be continued with the opinion of the group work learning should be continued. From this data about 48(85.71%) of them agreed on the group work learning should be continued because students share information, exchange knowledge and solve different types of problems with their group members. This indicates that group work learning and problem solving strategies creates the interaction between the students themselves especially those weak students help to solve the problem in group freely and actively then group work learning and problem solving strategy.

According to the item 15, about 18(32.1%) of them respondents strongly agreed, about 18(32.1%) of them the respondent agreed, about 7(12.5%) of the respondent explained disagreed and 12(21.4%) of the participants strongly disagreed by the statement group work learning and problem solving strategies should be four .In addition the majority of the respondents or about 36(64.2%) of the respondents explained that their agreement by the group size should be four and about 19(33.9%) of them not agreed on the group size should be

four. This indicates that most of the students interested to work in group size four to suitable discuss and solve the problem effectively.

In general, the results of this discussion also indicate that the group work learning and problem solving strategy is on appositve attitude towards mathematics classroom. Because when students work in group and solve a problem can also realize ideas, to exchange their experience, share their knowledge with their friends and increase their confidence in solving mathematics problem. Group work learning and problem solving strategy also emphasizes social interaction and relationships among groups of students in particular and among classmates.

4.4. Problem Solving Strategy Scale Result for Experimental and Control Groups

Results in appendix XVI showed that the mean problem solving strategy scale score of experimental group before the accomplishment the program was 131.12 and control group was 130.8. After the treatments mean score of problem solving strategy scale of experimental group was 142.01 and control groups students 130.0 respectively. The experimental group students mean score varied from 131.12 to 142.01 whereas from 130.8 to 130.0 for the experimental group students. This showed that there was a great improvement of experimental group students after the treatment whereas for the control group is not improved.

In order to decide whether a statistically significant difference between experimental groups pre and post problem solving strategy scale activity to solve mathematics problems which help them to improve their problem solving skill, the calculated paired sample t- test value and critical t- value were compared in table below

Table 8. Two tailed paired samples t- test to determine the significant difference problem solving strategy scale before and after the treatment.

Groups	Attitude	N	X	t _{cal}	Sig.(2-tailed)	t _{cri}
EG	Pre –attitude scale	56	131.1			2.045
	Post -attitude scale	56	142.0	8.749	0.000	
	Gain		10.8			
CG	Pre- attitude scale	56	130.8		0.000	2.045
	Post- attitude scale	56	130	2.048		
	Gain		0.8			

In the table showed that the calculated paired sample t-value ($t=8.749$) which was greater than critical t-value ($t=2.045$) for experimental group students. So, there is significant difference in using problem solving strategy scale item to solve mathematics problem of experimental group students before and after the treatment.

However, the calculated t- value ($t=2.048$) which was greater than critical t-value ($t=2.045$) for control group students. This shows that control group students improved is not significant as compared to experimental group conventional was not appropriate method.

Table 9. Independent sample t- test to determine the significant difference between experimental and control group problem solving strategy scale.

	Groups	N	Mean	T	Sig.(2tailed)	t _{cri}
Pre-attitude scale	Experimental	56	131.12	0.742	0.459	1.671
	Control	56	130.82			
	Mean gain		0.3			
Post-attitude scale	Experimental	56	142.01	5.366	0.00	1.67
	Control	56	130.00			
	Mean gain		12.01			

Table showed that above that pre and post mean scores problem solving strategy scale for experimental and control groups. There were no significant differences on attitude towards problem solving strategy scale mean scores, since the calculated t-value ($t=0.742$) was less than the critical t- value ($t=1.671$) it was assumed that two group started out with equivalent means. T-test for independent sample t-test was carried out to test whether the experimental and control groups differed significantly on the post-attitude problem solving strategy scale.

As it was indicated in the table significant difference was observed between experimental and control group attitude towards problem solving strategy scale items after the treatment,

Since, the calculated t-value (5.366) exceeded t-critical value (1.671). This indicates that the problem solving skills of the experimental group was improved than the control group.

Some researchers such as Ifamuyiwa, and Akinsola (2008) and Brush (1997) the results of study also indicate that the cooperative learning approach increase attitude towards mathematics and increase their confidence in solving mathematics problem. Cooperative learning also emphasizes social interaction and relationships among groups of students in particular and among classmates in general. Cooperative learning actively involves students in the learning process.

4.5. Teachers Level of Practice to Applying Problem Solve Strategy in Mathematics Classroom

Table 10. Teacher level of practice apply problem solving strategy in mathematics classroom

In Appendix XVX

No of items	Very good		Good		Satisfactory		Poor		Very poor	
	N	%	N	%	N	%	N	%	N	%
1	1	11.1	2	22.2	3	33.3	3	33.3	0	0
2	0	0	0	0	3	33.3	4	44.4	2	22.2
3	0	0	0	0	4	44.4	1	11.1	4	44.4
4	0	0	0	0	2	22.2	2	22.2	5	55.5
5	0	0	1	11.1	2	22.2	3	33.3	3	33.3
6	3	33.3	5	55.5	0	0	0	0	1	11.1
7	4	44.4	2	22.2	3	33.3	0	0	0	0
8	0	0	0	0	3	33.3	3	0	3	33.3
9	0	0	4	44.4	2	22.2	1	11.1	0	0
10	5	55.5	3	33.3	1	11.1	0	0	0	0
11	0	0	0	0	5	55.5	2	22.2	2	22.2
12	0	0	2	22.2	2	22.2	5	55.5	0	0

Table shows that 11.11% of teachers where conducted fine all activities in a logical sequence to solve mathematics problems, 22.22% of them where good, 33.33% of them satisfactory and 33.33% results where poor. To solve the problems, each step is a result of the previous step and precursor to the next step, 66.6% of teachers who taught grade eleven performed it well and 33.3% of them did it adequately. 33.3% of teacher used appropriate problem solving techniques however 44.4% of poor and 22.2% of them is very poor. From this understand that 33.3% of the teachers did not use problem solving technique properly.

From the above table it was observed that 44.44% use teacher did not encourage all students to be actively engaged in problem solving techniques. Almost all teachers (11.11% of them where poor and 44.44% of them where very poor) did not offer activities that promote the development of critical thinking and mathematical skill to solve mathematics problem.

To solve mathematics problems need to build a mental image of the problem situations that draw a picture and label all known information. 33.33% of them drawing picture and to solve problems that extended memory, however, 33.3 % of teachers where poor and 33.33% of them where very poor to interpret literal picture into a model which gives the essential information for a mathematical solution.

Basically, problem solving strategy needs all activities conducts in logical sequence (44.44% where poor and 22.22% where very poor), encourage the development of critical thinking and mathematical skill to solve mathematics problem (11.11% of them where poor and 44.44% where very poor). Translate literal picture in to abstract which gives only the essential information for a mathematical solution (33.33% of them where poor and 33.33% of them where very poor). This indicates that teacher level of practices to applying to solve mathematics problem in mathematics classroom was poor.

When teachers come a crossed a problem, generally they try to remember a rule to solve the problem. But this is not a good strategy, because there is no rule but a system. They should realize what and why they are doing and know the strength of the strategies

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The study was carried out to: the effect of group work learning and problem solving strategy on the student problem solving skill, Achievement and to know students attitudes towards mathematics classroom compared to traditional ways of instruction, teachers level of practice to applied problem solving strategy in mathematics class and to suggest the appropriate method of teaching. The study consisted of experimental and control groups. The experimental group was treated with the program by a teacher-centered style of instruction and they could adapt group work learning style of learning in 4 weeks of instruction and the control group was taught by using traditional method in Dinkula secondary and preparatory school.

The data were gathered through mathematics achievement test, problem solving performance test, observation check list and questionnaires. Pilot-test carried out to determine the reliability of attitude questionnaire items, achievement test and problem solving performance tests and attitude. The calculated cronbach alpha coefficients were 0.729, 0.748, 0.781 and 0.792 before and after the implementation of the program, respectively. Mean, t-test and effect size to analyze the data that obtained through mathematics achievement tests, problem solving test and questionnaires.

Based on the collected data, the students' result as shown in appendixes Pre and post-result of achievement test, pre and post result of problem solving performance test, pre and post test result of problem solving scale, teacher level of practice applies problem solving strategy observation check list and experimental group students attitude towards group work learning and problem solving strategy by using mean, effect size and t-test (paired sample t-test and independent t-test) respectively. In order to determine whether the treatment of applying group work learning and problem solving strategy had significantly influenced the students' academic achievement and problem solving skill or not; pre and post test of experimental group students were compared to control group. The result obtained from appendixes I, II, III, IV, V, VI, VII, VIII; the statistical analysis showed that

group work learning and problem solving strategy improved students' academic achievement by 9.41% and problem solving skill by 9% and students' attitude towards group work learning and problem solving strategy improved by 12.15%. Experimental group students had positive attitude towards group work learning and problem solving strategy in Appendixes XIX

There was not a statistically significant difference in the scores between the students taught by traditional and group work learning and problem solving strategy in the pre-test this mean that both control and experimental groups were equivalent before the implementation of the program. According to the result of the study group work learning and problem solving strategy was more effective than the traditional or convention instructional method to increase student's achievement and performance towards mathematics classroom. The study of the results revealed that group work learning and problem solving strategy more effective than the traditional instruction in improving students' achievement, problem solving skills and attitude. Generally, the finding of this study shows that students' attitude and their academic achievement and problem solving skill were positively increased compared to control group.

5.2. Conclusions

In general, this research indicates that group work learning and problem solving strategy had shown a positive impact in achievement, problem solving skill and attitude towards mathematics classroom. They had helped in improving the achievement and problem solving skills of students.

Group work learning exposes students more to realize and tend to work as a creative and acquire knowledge by themselves which the teacher only correct their misunderstanding. Group work learning removes teacher as the focal point of discussion and dispenser of the knowledge and sole owner of knowledge that cause to be students passive. Students are actively involved in group work learning technique that is not so in conventional learning method. In group work learning, students had to share their knowledge and experience with each other and developed their social interaction. This has shown that group work learning was more effective compared to conventional approach.

Problem solving strategy that helped students to analysis concepts and principles of mathematics in detail, relate the problem solving activity to general problem solving method and introduce them to the real world problem. Students who were taught by implementing problem solving strategies were willing to try solving the problems, and were eager to rise to solving challenging problems and it also developed their problem solving skills.

Group work learning and problem solving strategy were more effective in improving students' academic achievement, problem solving skills and attitude towards mathematics classroom compared conventional approach and teachers in schools, especially teachers who teach mathematics need to be aware the importance of group work learning and thus changing the practice of teacher-centered teaching methods to student-centered teaching methods applied . Therefore, group work learning and problem solving strategy develop students' academic performance (problem solving skills), achievement and positive attitude toward group work learning and problem solving strategy and attitude toward mathematics classroom.

5.3. Recommendations

Finally based on the data collected and conclusion drawn. The following recommendations were forwarded

- ✓ Group work learning and problem solving strategy requires in classroom and out of the classroom activities.
- ✓ Mathematics teacher should implement group work learning and problem solving strategy at preparatory school level and developed to applied problem solving performance in mathematics classroom.
- ✓ Awareness about this approach should be developed in preparatory school.
- ✓ Educators are urged to consider the group work learning and problem solving strategy approach as one of their teaching strategies.
- ✓ Crating preparatory school atmosphere which is appropriate with group work learning and problem solving strategy approach is important for practicing the method.
- ✓ To promote the implementation of group work learning strategy effectively, both teachers and students would need to undergo a training course in this kind of learning. Although the finding of study support the effectiveness of group work learning and problem solving strategy for students' achievement and their knowledge retention, the sample of this study is restricted to only 112 participants. Therefore, future studies should apply group work learning and problem solving strategy with more participants to generate more evidence on the effects of group work learning.

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7. APPENDICES

APPENDIX. I

Table 1. Pre-test result of achievement test for experimental group

Student ID	20%	100%	Student ID	20%	100%
E01	10	50	E29	11	55
E02	6	30	E30	6	30
E03	9	45	E31	12	60
E04	8	40	E32	13	65
E05	13	65	E33	10	50
E06	7	35	E34	4	20
E07	12	60	E35	9	45
E08	10	50	E36	13	65
E09	5	25	E37	9	45
E10	11	55	E38	12	60
E11	15	75	E39	12	60
E12	8	40	E40	11	55
E13	10	50	E41	7	35
E14	12	60	E42	12	60
E15	12	60	E43	9	45
E16	10	50	E44	13	65
E17	11	55	E45	11	55
E18	9	45	E46	9	45
E19	9	45	E47	9	45
E20	13	65	E48	8	40
E21	12	60	E49	5	25
E22	11	55	E50	9	45
E23	7	35	E51	6	30
E24	10	50	E52	13	65
E25	9	45	E53	13	65
E26	10	50	E54	12	60
E27	15	75	E55	14	70
E28	9	45	E56	16	80

Appendix. II

Table 2. Post-test result of achievement test for experimental group

Student. ID	20%	100%	Student. ID	20%	100%
E01	11	55	E29	10	50
E02	14	70	E30	11	55
E03	9	40	E31	15	75
E04	13	65	E32	13	65
E05	15	75	E33	11	55
E06	9	45	E34	9	45
E07	14	70	E35	9	45
E08	11	55	E36	15	70
E09	12	60	E37	12	60
E10	13	65	E38	11	55
E11	17	85	E39	15	75
E12	11	55	E40	12	60
E13	9	45	E41	11	55
E14	13	65	E42	13	65
E15	12	60	E43	13	65
E16	14	70	E44	14	70
E17	13	65	E45	13	65
E18	7	35	E46	8	40
E19	13	65	E47	15	75
E20	17	85	E48	13	65
E21	13	65	E49	18	90
E22	10	50	E50	17	85
E23	10	50	E51	11	55
E24	9	45	E52	12	60
E25	11	55	E53	15	75
E26	13	65	E54	12	60
E27	16	80	E55	17	85
E28	10	50	E56	18	90

Appendix. III

Table 3. Per- test result for problem solving performance for experimental group

Student.ID	25%	100%	Student.ID	25%	100%
E01	12	48	E29	12.5	50
E02	8.5	34	E30	11.5	46
E03	9.5	38	E31	14.5	58
E04	7.5	30	E32	12	44
E05	12	48	E33	12.5	50
E06	12.5	50	E34	7	28
E07	13	52	E35	11	44
E08	8.5	34	E36	8	32
E09	11.5	42	E37	12.5	50
E10	9.5	38	E38	10	40
E11	10.5	42	E39	17	68
E12	11	44	E40	12.5	640
E13	11.5	46	E41	10.5	42
E14	16.5	66	E42	11.5	46
E15	14.5	58	E43	12	48
E16	10.5	42	E44	13	52
E17	11.5	46	E45	12.5	50
E18	7.5	30	E46	8	32
E19	13	52	E47	16.5	62
E20	9.5	38	E48	14	56
E21	12	48	E49	11	44
E22	13	52	E50	12	48
E23	13.5	54	E51	15.5	62
E24	16	64	E52	10	40
E25	13.5	54	E53	12.5	50
E26	13.5	54	E54	6.5	26
E27	11	44	E55	10	40
E28	10.5	42	E56	14	56

APPENDIX. IV

Table 4. Post – test result problem solving performance for experimental group

Student .ID	25%	100%	Student.ID	25%	100%
E01	17.5	70	E29	15	60
E02	9	36	E30	14	56
E03	10	40	E31	18	72
E04	12.5	50	E32	19	76
E05	11	44	E33	15	60
E06	14	56	E34	13	52
E07	12	48	E35	15.5	62
EO8	6	24	E36	17	68
E09	11.5	42	E37	10.5	42
E10	11	44	E38	11.5	46
E11	15	60	E39	21	84
E12	13.5	54	E40	12	48
E13	10	40	E41	11	44
E14	20	80	E42	19	76
E15	16.5	66	E43	13.5	54
E16	18.5	74	E44	14	56
E17	9.5	38	E45	13.5	54
E18	16	64	E46	21	84
E19	15.5	62	E47	14.5	58
E20	18	72	E48	15.5	62
E21	15	60	E49	16	64
E22	12	48	E50	10	40
E23	13.5	54	E51	15	60
E24	13.5	54	E52	12	60
E25	17.5	70	E53	18	72
E26	11	44	E54	10.5	42
E27	16	64	E55	12	48
E28	11.5	42	E56	12.5	50

APPENDIX. V**Table 5. Pre-test result for control group student**

Student.ID	20%	100 %	Student.ID	20%	100%
C01	11	55	C29	16	80
C02	7	35	C30	13	65
C03	10	50	C31	14	70
C04	12	60	C32	12	60
C05	6	30	C33	17	85
C06	10	50	C34	13	65
C07	8	40	C35	14	70
C08	9	45	C36	6	30
C09	11	55	C37	13	65
C10	10	50	C38	14	70
C11	11	55	C39	11	55
C12	8	40	C40	6	30
C13	10	50	C41	12	60
C14	12	60	C42	13	65
C15	14	70	C43	12	60
C16	9	45	C44	10	50
C17	13	65	C45	10	50
C18	11	55	C46	11	55
C19	8	40	C47	7	35
C20	10	50	C48	4	20
C21	7	35	C49	11	55
C22	9	45	C50	13	65
C23	5	25	C51	15	75
C24	10	50	C52	14	70
C25	9	45	C53	14	70
C26	12	60	C54	11	55
C27	11	55	C55	7	35
C28	7	35	C56	11	55

APPENDIX .VI

Table 6. Post test result for control group students

Student. ID	20%	100%	Student ID	20%	100%
C01	12	60	C29	11	55
C02	8	40	C30	10	50
C03	9	45	C31	15	75
C04	11	55	C32	14	70
C05	6	30	C33	13	65
C06	11	55	C34	12	60
C07	9	45	C35	12	60
C08	8	40	C36	9	45
C09	12	60	C37	10	50
C10	9	45	C38	14	70
C11	12	60	C39	12	60
C12	7	40	C40	11	55
C13	13	65	C41	11	55
C14	11	55	C42	12	55
C15	12	60	C43	11	55
C16	10	50	C44	10	50
C17	11	55	C45	8	40
C18	12	60	C46	11	55
C19	12	60	C47	10	50
C20	9	45	C48	11	55
C21	11	55	C49	14	70
C22	6	30	C50	13	65
C23	8	40	C51	13	65
C24	7	35	C52	12	60
C25	13	65	C53	17	85
C26	6	30	C54	13	65
C27	13	65	C55	12	60
C28	12	60	C56	11	55

APPENDIX .VII

Table 7. Pre- test for problem solving performance for control group students

Student.ID	25%	100%	Student. ID	25%	100%
C01	12	50	C29	17.5	70
C02	6.5	26	C30	11	44
C03	11	44	C31	16.5	66
C04	13	52	C32	17	68
C05	6	24	C33	15.5	62
C06	7.5	30	C34	13	52
C07	12	48	C35	17	68
C08	8	32	C36	8.5	34
C09	11.5	46	C37	11	44
C10	10	40	C38	17.5	70
C11	13.5	54	C39	13.5	54
C12	6.5	26	C40	6.5	26
C13	8.5	34	C41	14	56
C14	13	52	C42	8.5	34
C15	16	64	C43	14.5	58
C16	10	40	C44	13.5	54
C17	14.5	58	C45	17.5	70
C18	14	56	C46	12	48
C19	10	40	C47	8.5	34
C20	11.5	46	C48	11	44
C21	14	56	C49	15	60
C22	7.5	30	C50	14	56
C23	11	44	C51	18	72
C24	15.5	62	C52	15	60
C25	9	36	C53	19	76
C26	16	64	C54	13	52
C27	15	60	C55	11.5	46
C28	7.5	30	C56	12.5	50

APPENDIX .VIII

Table 8.Post -test problem solving performance for control group

Student. ID	25%	100%	Student ID	25%	100%
C01	8.5	34	C29	16	64
C02	11	44	C30	10.5	42
C03	12.5	50	C31	17	68
C04	15	60	C32	15	60
C05	9.5	38	C33	16	64
C06	10	40	C34	15	60
C07	12.5	50	C35	14.5	58
C08	9	36	C36	11	44
C09	13.5	54	C37	13	52
C10	7.5	30	C38	7	28
C11	11	44	C39	14	56
C12	8.5	34	C40	10	40
C13	10.5	40	C41	11.5	46
C14	9	36	C42	14	56
C15	14.5	58	C43	15	60
C16	12	48	C44	15.5	62
C17	17	68	C45	16.5	66
C18	14.5	58	C46	11	44
C19	12	48	C47	9	36
C20	14.5	58	C48	12.5	50
C21	12.5	50	C49	12.5	50
C22	12	48	C50	15.5	62
C23	13.5	54	C51	19	76
C24	10.5	42	C52	16	64
C25	11	44	C53	16.5	66
C26	9.5	38	C54	15	60
C27	13	52	C55	16	64
C28	9	36	C56	17	68

APPENDIX .IX

Table 9. Pre -test result for achievement test pilot group

Student. ID	20%	100%	Student.ID	20%	100%
P01	17	85	P21	14	70
P02	12	60	P22	5	25
P03	13	65	P23	10	50
P04	14	70	P24	18	90
P05	16	80	P25	15	75
P06	15	75	P26	10	50
P07	13	65	P27	15	75
P08	9	45	P28	15	75
P09	2	10	P29	11	55
P10	6	30	P30	10	50
P11	8	40	P31	17	85
P12	7	35	P32	11	55
P13	13	65	P33	16	80
P14	17	85	P34	9	45
P15	13	65	P35	16	80
P16	11	55			
P17	12	60			
P18	18	90			
P19	9	45			
P20	8	40			

APPENDIX .X

Table 10. Post -test result for achievement pilot group

Student.ID	20%	100%	Student. ID	20%	100%
P01	17	85	P21	13	65
P02	13	65	P22	3	15
P03	12	60	P23	13	65
P04	12	60	P24	17	85
P05	17	85	P25	13	65
P06	17	85	P26	6	30
P07	13	65	P27	13	65
P08	8	40	P28	18	90
P09	6	30	P29	13	65
P10	13	65	P30	12	60
P11	7	35	P31	18	90
P12	9	45	P32	13	65
P13	12	60	P33	17	85
P14	18	90	P34	9	45
P15	13	65	P35	18	90
P16	8	40			
P17	13	65			
P18	16	80			
P19	7	35			
P20	10	50			

APPENDIX .XI

Table 11. Pre test result for problem solving performance for pilot group

Student.ID	20%	100%	Student .ID	20%	100%
P01	21	85	P21	14.5	72.5
P02	6.5	32.5	P22	4.5	22.5
P03	13	65	P23	15	75
P04	6	30	P24	10	50
P05	8	40	P25	7	35
P06	0	40	P26	6	30
P07	7	35	P27	9.5	47.5
P08	4	20	P28	9.5	47.5
P09	5	30	P29	10.5	52.5
P10	17.5	87.5	P30	8.5	42.5
P11	4	20	P31	12.5	62.5
P12	8	40	P32	11	55
P13	9	45	P33	16	80
P14	18	90	P34	5.5	27.5
P15	13	65	P35	10.5	52.5
P16	10.5	52.5			
P17	17	85			
P18	17	85			
P19	18.5	92.5			
P20	9	45			
P21	14.5	72.5			

APPENDIX .XII

Table 12. Post -test result of problem solving performance pilot group

STD.ID	20%	100%
P01	21	84
P02	18	72
P03	9	45
P04	17	68
P05	15	60
P06	8	32
P07	13	62
P08	19	78
P09	11	44
P10	17.5	70
P11	6	30
P12	20.5	82
P13	16	64
P14	6	24
P15	7	28
P16	5	20
P17	8	32
P18	9	36
P19	13.5	54
P20	19	76
P21	12.5	62
P22	18.5	74
P23	5	20
P24	17.5	70
P25	22	88
P26	10	40
P27	14	56
P28	7	28
P29	8	32
P30	14	56
P31	17	68
P32	24	86
P33	15.5	62
P34	13.5	56
P35	20	80

APPENDIX. XIII

Table 13. Pre-test and post-test result problem solving strategy scale result for experimental and control groups

Experimental group				Control group			
St.ID	Before the experiment	After the experiment		St.ID	Before the experiment	After the experiment	
E01	125	128		C01	149	148	
E02	123	131		C02	141	138	
E03	126	136		C03	133	131	
E04	121	130		C04	129	129	
E05	121	136		C05	132	129	
E06	117	129		C06	128	124	
E07	125	128		C07	132	131	
E08	121	136		C08	119	117	
E09	131	141		C09	135	134	
E10	128	133		C10	122	122	
E11	130	136		C11	132	123	
E12	131	141		C12	129	131	
E13	124	139		C13	117	121	
E14	121	130		C14	123	128	
E15	136	157		C15	137	132	
E16	149	158		C16	143	140	
E17	118	131		C17	137	133	
E18	141	146		C18	141	141	
E19	134	147		C19	136	132	
E20	112	123		C20	131	123	
E21	139	156		C21	130	126	
E22	127	133		C22	126	131	
E23	148	159		C23	112	118	
E24	113	117		C24	125	127	
E25	139	145		C25	118	124	
E26	155	160		C26	147	145	
E27	165	171		C27	140	132	
E28	123	128		C28	131	131	
E29	118	127		C29	133	132	
E30	146	155		C30	139	140	
E31	151	157		C31	143	141	
E32	128	136		C32	143	139	
E33	136	154		C33	149	153	
E34	147	155		C34	134	132	
E35	141	143		C35	142	143	
E36	134	149		C36	145	145	

E37	139	143	C37	115	120
E38	152	161	C38	132	130
E39	134	141	C39	126	124
E40	137	138	C40	129	129
E41	142	143	C41	128125	126
E42	134	138	C42	124	124
E43	128	139	C43	127	125
E44	134	136	C44	125	127
E45	132	134	C45	126	123
E46	133	133	C46	119	125
E47	134	137	C47	131	120
E48	127	140	C48	127	130
E49	130	130	C49	120	127
E50	129	132	C50	123	120
E51	129	136	C51	135	124
E52	136	140	C52	125	134
E53	132	132	C53	135	125
E54	130	136	C54	131	131
E55	128	134	C55	123	131
E56	128	131	C56	132	124
Average	132.10	142.08		130.82	130

Table 14. Appendix XIV. Pre -achievement test for experimental and control group**Direction I choose the best answers**

- Let $V_1 = \begin{pmatrix} \sqrt{3} \\ -1 \end{pmatrix}$ and $V_2 = \begin{pmatrix} -2\sqrt{3} \\ 2 \end{pmatrix}$ be vectors then the vector $V_1 + V_2$ is equal to
 A. $\begin{pmatrix} 3\sqrt{3} \\ 1 \end{pmatrix}$ B. $\begin{pmatrix} -\sqrt{3} \\ 1 \end{pmatrix}$ C. $\begin{pmatrix} -\sqrt{3} \\ 1 \end{pmatrix}$ D. $\begin{pmatrix} 2\sqrt{3} \\ -1 \end{pmatrix}$
- Let $U=(2,5)$ and $V = (-3, 8)$ be vectors .Then the vector $U - V$ equal to
 A.(5, 13) B.(5, -3) C.(-1, 3) D.(-5, -3)
- If $\vec{t} = 2\vec{i} - 3\vec{j}$ $\vec{b} = 3\vec{i} - \vec{j}$ $\vec{c} = \vec{i} - \vec{j}$ then $\vec{t} \cdot (2\vec{b} - \vec{c}) = ______$
 A. -10 B. 7 C. 10 D. 13
- Let vectors $\vec{U} = (-2, 5)$ and $\vec{V} = (2, 4)$ Then $2\vec{U} - \frac{1}{2}\vec{V} - 3\vec{j}$ is equal to
 A. (-8, 12) B. (-5, 9) C.(-8, 9) D.(-5, 5)
- Which of the following vectors is parallel and opposite to vector $\vec{A} = 3\vec{i} - 4\vec{j}$
 A. $\vec{i} - \frac{4}{3}\vec{j}$ B. $-6\vec{i} - 8\vec{j}$ C. $-\frac{3}{2}\vec{i} + 2\vec{j}$ D. $\frac{3}{5}\vec{i} + \frac{4}{5}\vec{j}$
- If $A=(2, -1)$ $B = (3, 2)$ and $C = (-2, t)$ Then for what value of t $\overline{AB} \perp \overline{AD}$
 A. -1 B. 0 C. 3 D. 5
- The Norm of \vec{V} is $\vec{V} = 2\vec{i} + 3\vec{j} - 2(\vec{i} + 3\vec{j})$ A.11 B. $\sqrt{10}$ C. 3 D. $\sqrt{3}$
- Let $\vec{V} = \vec{i} - \vec{j}$ and $\vec{U} = 2\vec{i} - 3\vec{j}$ what is the unit vector in the direction of $\vec{a} - \vec{b}$?
 A. $\frac{1}{5}\vec{i} - \frac{2}{5}\vec{j}$ B. $-\frac{1}{\sqrt{5}}\vec{i} + \frac{2}{\sqrt{5}}\vec{j}$ C. $\frac{1}{\sqrt{5}}\vec{i} - \frac{2}{\sqrt{5}}\vec{j}$ D. $\frac{-1}{5}\vec{i} - \frac{2}{5}\vec{j}$
- Let vectors $\vec{U} = (6, x + y)$ and $\vec{V} = (y - 2x, -1)$ in the coordinate form Then
 $2\vec{v} - \vec{U} = (0, 1)$ then $x = ______ and y = ______ respectively$
 A. 4, -3 B. $\frac{-3}{2}, 5$ C. -2, 7 D. -2, -1
- For a point A, B and C on the a line (collinear) where B is between A and C Then
 $\overline{BA} = ______ A. \overline{AB} \quad B. \overline{AC} - \overline{BC} \quad C. \overline{AC} + \overline{BC} \quad D. \overline{BC} - \overline{AC}$
- Which of the following is true about vectors $\vec{U} = -\vec{i} + 2\vec{j}$ and $\vec{V} = 2\vec{i} - \vec{j}$
 A. $\vec{U} + \vec{V}$ is unit vector B. $\vec{U} + \vec{V}$ and $\vec{U} - \vec{V}$ are perpendicular
 C. $(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}})$ is a unit vector in the direction of $\vec{U} - \vec{V}$
 D. Angle between $\vec{U} - \vec{V}$ and \vec{i} is $\frac{\pi}{4}$

12. If θ is the Angle between the vectors $\vec{A} = 2\vec{i} - \vec{j}$ and $\vec{B} = \vec{i} + \vec{j}$ then $\cos\theta$ is equal to
 A. $\frac{1}{\sqrt{10}}$ B. $\frac{1}{2}$ C. $\frac{\sqrt{3}}{2}$ D. $\frac{2}{5}$
13. For a vector \vec{a} and \vec{b} such that $|a| = 4$ and $|2a - b| = |a + b|$ then $\vec{a} \cdot \vec{b}$ is equal to
 A. 8 B. 10 C. 12 D. 24
14. Parametric equation of a line $L: 2x - 3y - 7 = 0$ is
 A. $(x, y) = (0, -7) + t(2, 3)$
 B. $(x, y) = (-3, -4) + t(1, -6)$
 C. $(x, y) = (2, -1) + t(3, 2)$
 D. $(x, y) = (-4, 2) + t(1, 5)$
15. If \vec{a} and \vec{b} are vectors such that $|\vec{a}| = 1$, $|\vec{b}| = \sqrt{3}$ and $\vec{a} \cdot \vec{b} = -3$. then $|\vec{a} - \vec{b}| =$ ____
 A. 5 B. 7 C. $\sqrt{13}$ D. $\sqrt{22}$
16. The rectangular form of equation of a line given in parametric form as
 $(x, y) = (2, 5) + t(1, -2)$ is
 A. $Y + 2x = 9$ B. $3y - 4x = 3$ C. $y = 3x - 5$ D. $-2y + x - 3 = 0$
17. Which of the following represents equation of a line tangent to circle
 $x^2 + y^2 - 8x + 4y = 0$ At the point $(0, -4)$ A. $2y + 8x - 32 = 0$
 B. $4x - y - 8 = 0$ C. $y + 2x + 4 = 0$ D. $x - 4y + 16 = 0$
18. Which of the following is the vector equation of the line containing points $(1, 2)$ and
 $(3, 4)$
 A. $(x, y) = (1, 2) + t(3, 4)$
 B. $(x, y) = (1, 2) + t(1, 1)$
 C. $(x, y) = (2, -1) + t(1, 0)$
 D. $(x, y) = t(2, 2)$
19. Equation of tangent line to circle with center $C = (1, 1)$ and $A = (2, 3)$ is point of tangency is
 A. $3x + y = 9$ B. $x + 2y = 8$ C. $3x - 2y = 0$ D. $x + y = 5$
20. Which of the following is a vector that lies on the line through $(0, 0)$ and $(2, 4)$
 A. $\vec{U} = (2, 1)$ B. $\vec{U} = \left(\frac{1}{2}, 2\right)$ C. $\vec{U} = (-1, -2)$ D. $\vec{U} = (-2, -6)$

Table 15. Appendix XV. Pre –test problem solving performance for experimental and control Group

Direction II work out

1. Find the unit vector in the direction of vector

- a. (2 , 3) B. (-5 , -2)

2. Find the angle between the following pairs of vectors

A. $\vec{U} = -\vec{i} + 2\vec{j}$, $\vec{V} = \sqrt{2}\vec{i} - \vec{j}$ b. $\vec{U} = -\vec{i} + 2\vec{j}$, $\vec{V} = 2\vec{j} - \vec{j}$

3. Given vectors \vec{U} and \vec{V} with magnitudes of $|\vec{U}| = \sqrt{3}$ and $|\vec{V}| = 2$ and

angle between them is $\theta = \pi/6$ then find $|\vec{U} + 2\vec{V}|$

4. Find the value of t so that the $\vec{U} = \vec{i} - \vec{j}t$ and $\vec{V} = -2\vec{j}$ are perpendicular

5. Find the vector equation form of a line $\frac{x-3}{2} = \frac{y+2}{3}$

6. Find the parametric equation of a line passes through points (-2 , 3) and (1 , -1)

7. Show that triangle with vertices at A(-8 , 1) , B(-1 , -6) and C(2 , 4) is isosceles triangle

8. Find the equation of tangent line to the circle $(x + 2)^2 + (y - 3)^2 = 25$ at a point (1 , 7)

9. If $\vec{U} = (x + y , 1)$ and $\vec{V} = (2 , 2x - y)$ for $x, y \in \mathbb{R}$, then find the value of x and y

10. Are the point A , B and C collinear A(1 , -4) , B(-2 , -3) C(11 , -11)

Table 16. APPENDIX XVI. Post achievement test for experimental and control group**Direction one choose the best answer only**

- A translation T takes (1, -3) to (-1, 0) Then where does T takes (0, 0)
A. (0, 0) B. (-3, -1) C. (-2, 3) D. (0, -3/2)
- What translation vector took $y = x^2 + 2x$ to $y = x^2$
A. (0, -1) B. (1, -1) C. (1, 1) D. (-1, -1)
- A translation T takes p=(-1, 0) to Q=(1, 3)
What is the image of ellipse? $9(x - 1)^2 + 4(y + 2)^2 = 36$
A. $9(x - 3)^2 + 4(y - 1)^2 = 36$ B. $9(x + 3)^2 + 4(y - 1)^2 = 36$
B. $9(x + 1)^2 + 4y^2 = 36$ D. $9(x - 2)^2 + 4(y - 1)^2 = 36$
- If a translation T takes (1, 2) to (3, 4) Then T takes $2x + 3y + 6 = 0$ to
A. $2x + 3y - 16 = 0$ B. $2x + 3y + 16 = 0$ C. $2x + 3y - 4 = 0$ D. $3x + 2y - 4 = 0$
- A translation takes $x^2 + y^2 - 4x - 1 = 0$ to $x^2 + y^2 - 4x - 1 = 0$ what is the image of (1, 3) under this transformation
A. (3, 4) B. (3, 2) C. (-1, 1) D. (-2, 3)
- The image of point (-1, 3) reflected through the line $y = x$ is
A. (3, -1) B. (-3, 1) C. (1, 3) D. (-1, -3)
- If point p=(-1, 2) is reflected in the line $y = x - 1$, what is the image of P
A. (1, -2) B. (-1, 0) C. (2, -2) D. (3, 1)
- What is the image of a point (-4, 5) when it is rotated about the origin by 90°
A. (-5, -4) B. (4, -5) C. (-5, 4) D. (4, 5)
- The image of point A under 180° rotation about the origin is A' (2, -4) what are the coordinates of point A?
A. (2, 4) B. (-4, -2) C. (4, -2) D. (-4, 2)
- Which of the following capital letter is reflection image itself across a horizontal
A. M B. O C. N D. P
- The composition of two reflection across two intersecting lines is equivalent to which isometry
A. Translation B. rotation C. reflection D. glide rotation
- Which statement is not true for isometries

- A. The image and pre image are congruent
 B. The image and pre image are similar but not congruent
 C. The lengths of segments are preserved
 D. Measure of angle are preserved
13. Point $(-2, 3)$ is reflected in the x-axis in which quadrant does its image lie?
 A. I B. II C. III D. IV
14. What is the image of $A(5, 2)$ under R_{90° ?
 A. $(-5, 2)$ B. $(5, -2)$ C. $(2, 5)$ D. $(-2, 5)$
15. If the letter P is rotated 180° degree which is the resulting figure?
 A. d B. P C. P D. b
16. what is image of the line $x-3y=2$ after rotation about the origin through $\theta = 270^\circ$
 A. $x-3y=2$ B. $y+3x=-2$ C. $-x+3y=2$ D. $y-3x=-2$
17. find the image of a point $M(4, 1)$ in the line reflection $x=3$
 A. $(-2, 1)$ B. $(2, 1)$ C. $(4, 5)$ D. $(4, -5)$
18. The image of the point $(2, 2)$ reflected in line passing through the origin and making 30° with x- axis
 A. $(2, -2)$ B. $(1+\sqrt{3}, \sqrt{3}-1)$ C. $(\sqrt{3}-1, 1+\sqrt{3})$ D. $(\sqrt{3}, -\sqrt{3})$
19. What is the image of point $P(1, -2)$ after reflection in the line $y=3x+1$
 A. $(\frac{13}{5}, \frac{4}{5})$ B. $(\frac{-13}{5}, \frac{-4}{5})$ C. $(\frac{-4}{5}, \frac{-7}{5})$ D. $(\frac{-8}{5}, \frac{-14}{5})$
20. Image of the circle $x^2 + y^2 - 2x = 5$ under reflection in the line $x=-1$ is
 A. $(x+3)^2 + y^2 = 5$ C. $(x-1)^2 + (y+2)^2 = 5$
 B. $(x+3)^2 + y^2 = 6$ D. $(x+2)^2 + y^2 = 6$

Table 17. Appendix XVII. Post test problem solving performance for experimental and control Group

Direction II work out

1. Find the equation of the image of the circle $(x + 1)^2 + (y - 3)^2 = 5$ when Translated by the vector \overline{PQ} , where $p=(1, -1)$ and $Q=(-4, 3)$
2. Triangle ABC is transformed in to triangle A'B'C' by translation vector $(4, 3)$ if $A=(2, 1)$, $B=(3, 5)$ and $C=(-1, -2)$. Find the coordinates of A', B' and C'
3. If translation T takes the origin to $(4, -5)$ find the image of the line $y=3x+2$
4. Find the image of appoint $(-4, 3)$ after a reflection about the line $L:y=x-2$
5. In a reflection the image of the line $y-2x=3$ is the line $2y-x=9$ find the axis of reflection
6. Given an equation of a circle $(x - 2)^2 + (y - 3)^2 = 25$ find equation of the image circle after a reflection about the line $y=x+3$
7. Find the image of the line $L:y=2x+1$ after it has refelected along the line $l: y=2x+6$
8. Find the image of $P(3, 1)$ when it is rotated through $\theta = \frac{\pi}{2}$ about $(-2, 3)$
9. Find the image of $(4, 2)$ when it is rotated through $\theta = \frac{\pi}{3}$ *about the origin*
10. Find the equation of a line $x+y=0$ after it has been rotated by $\theta = 270^\circ$ about $(3, 2)$

APPENDIX. XVII

Dear student; This scale was prepared to determine the strategies which you used while solving the mathematics problem and how frequently you used them. For the validity of this research specifying your actual ideas has a special important for each item below please mark (x) how frequently you did each activity by putting a check mark in to the appropriate box. Thank you for participating in this study

Table 18. Problem solving strategy scale (PSSS)

How frequently you do each activity below while solving mathematics problems?	Always	Frequently	Sometimes	Rarely	Never
1 I reread the problem					
2 I try to comprehend the problem					
3 I think concepts about the problem					
4 I express the problem by own sentence					
5 I write the given variable about the problem					
6 I express the problem by figures and diagrams					
7 I review the rules and principles about the problem					
8 I write the asked variable about the problem					
9 I use the trial and error method in order to find a solution					
10 I concentrate abstract concepts about the problem					
11 I find possible solutions for the problem					
12 I check the operation steps used in the solution of the problem					
13 I divide the problem in to sub problem					
14 I think of weather the answer given to the problem was logical					
15 I apply the first remembered solution					
16 I visualize the problem by drawing					
17 I try different ways for the solution					
18 I think of what about the problem was					
19 I think of the different aspects of the problem from the similar problems					

-
- 20 I categorize the information in the problem
 - 21 I define the problem in more simple language
 - 22 I understand the important points in the problem
 - 23 I focus onto the solution of the problem
 - 24 I interpret the results obtained from the problem
 - 25 I think of the limitations in the problem
 - 26 I plan for the solution
-

APPENDIX. XIX

This questionnaire is prepared to be completed by student who learning in Dinkula secondary and preparatory school. The objective of the questionnaire is to collect the information about the attitude the students towards the effectiveness of group work learning and problem solving strategies. The information you provide is valuable for the successes of the research; therefore, your genuine response is highly appreciated. Please be honest to filling the questionnaires.

Instruction: under the following table there are different statement to the left and five possible response scale strongly agree (SA), agree (A), undecided (U), disagree (D), and strongly disagree (SD) to the right. For each statement, put the sign (x) under the response scale that most closely corresponds to how you think and feel about the statement.

1. Strongly agree (SA)
2. Agree (A)
3. Undecided (U)
4. Disagree(D)
5. Strongly disagree (SD)

Name: _____

Sex: _____

Table 19. The student's attitude towards group work learning and problem solving strategy on experimental group student

No	Questionnaire statement	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	My work is better organized when I work in a group					
2	Group work problem solving strategies helped me to understand the topic more					
3	Group work problem solving strategies encourage to exchange knowledge, information and experience					
4	Group work problem solving strategies made problem solving easier.					
5	Group work learning creates relaxed classroom					

-
- 6 Group work learning and problem solving strategy allowed me to apply my knowledge to solve problems
 - 7 Group work learning create interaction with other student
 - 8 Group work problem solving strategy enables me to use others ideas together with my own
 - 9 Group work learning and problem solving strategies help weaker students in group
 - 10 Group work learning and problem solving strategies create good performance to solve mathematics problems
 - 11 Group work problem solving strategy Students actively participate in the teaching and learning process.
 - 12 Difficult to work problem solving in groups because we spend much time talking about other things
 - 13 Group work Problem solving strategy steps waste time to solve mathematics problems
 - 14 The group work learning should be continued
 - 15 Maximum group size should be 4
-

APPENDIX. XX

Table20. Teacher level of practice applies problem solving strategy observation checklist

Name of school: _____

Name of Teacher _____ Gender _____ Teaching

Experience _____ years _____

No	Criterion	VG	G	S	P	VP
1	Teacher all activity are conducted in sequence to solve mathematics problems					
2	Teachers use appropriate problem solving techniques.					
3	Teacher encourage all students to be actively engaged in problem solving techniques					
4	Teacher provides activities that promote the development of critical thinking and mathematical skill to solve mathematics problem					
5	Problem solving strategy is drawing pictures and writing the procedures using words and symbols use them properly					
6	Teachers comes across to solve mathematics problems generally tries to remember a rule to solve problem					
7	Problem solving process in each step is a result of the previous step and a precursor to the next step					
8	To solve mathematics problems need to construct a mental image of the problem situation that draw a picture and label all known information. how he/she assists students to develop this activity					
9	Teacher interprets the statement of problems using picture					
10	Teacher constructs specific algebraic equations that will enable him/her to calculate the target variable. He/she begins with an equation containing the target variable and identify any unknowns in that solution					
11	Evaluation suggests that the answer is correct or incorrect or unreasonable; they have to makes a statement to that effect and explain their reasoning					
12	Problem solving strategy can apply for a solution of both routine and non-routine problem How does the teacher carry out this activity?					

Where: VG= very good, G=good, S= satisfactory, P= poor and VP= very poor

APPENDIX. XXI

Unit 8: Vectors and Transformation of the Plane (16 periods)

Unit outcomes: Students will be able to:

- know basic concepts and procedures about vectors and operation on vectors.
- know specific facts about vectors.
- apply principles and theorem about vectors in solving problems involving vectors.
- know basic concepts about transforming of the plane.
- apply methods and procedures in transforming plane figures.

Table21. Lesson plan on vectors and Transformation of the plane

Unit	Sub-unit	Number of periods	
		Sub-unit	total
Unit 8: Vectors and Transformation of the Plane	8.1 vectors and scalars	2	16
	8.2 representation of vectors	1	
	8.3 scalar(inner or dot) product	2	
	8.4 Application of Vectors	3	
	8.5 Transformations of the plane	8	